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AND
METAL MINER.

VOL. XVI.—NO. 1. SCRANTON, PA., AUGUST, 1895. WITH WHICH IS COMBINED THE MINING HERALD.

Written for THE COLLIERY ENGINEER AND METAL MINER.

ELLANGOWAN COLLIERY.

ONE OF THE MOST EXTENSIVE COAL MINES IN THE WORLD.

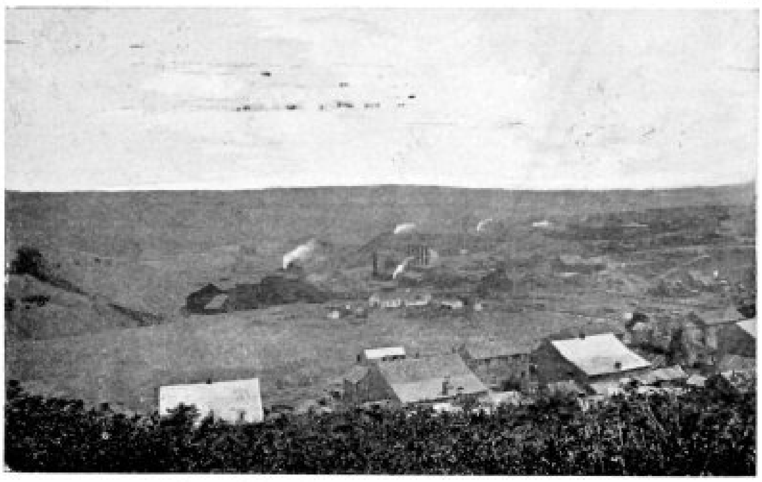
A Description of The Seams Worked, The Methods of Working and the Surface Improvements.

(By Geo. B. Hadesty, Mining Engineer.)

One of the oldest, largest and most productive collieries owned and operated by the Philadelphia and Reading Coal and Iron Company is Ellangowan. It is situated in the Western Middle anthracite coal field of Pennsylvania, in Schuylkill county, on a line between the towns of Mahanoy City and Shenandoah and about midway between them. The workings are principally on the south dip, in what is classified as the Ellangowan Basin, (which is shown in Figure 1,) and they are so extensive that they approach Shenandoah City and Knickerbocker collieries, on the north, North Mahanoy and Suffolk collieries on the east, Suffolk and Maple Hill collieries on the south, and West Shenandoah, Turkey Run, and Cambridge collieries on the west.

Ellangowan colliery was first opened about 1860, under the name of Maple Dale, by Mr. James Lannigan, and to this day is called "Lannigans" by many of the working people.

Its workings at that time, and on up to about 1870 consisted of drifts, all above water level. About 1870 the lands on which the colliery is situated became by purchase the property of the Philadelphia and Reading Coal and Iron Company, and about 1873 they began operating the colliery.



GENERAL VIEW OF ELLANGOWAN VALLEY, LOOKING SOUTH.

During 1871 and 1872 a shaft with two (2) hoisting compartments, each 7 ft. by 12 ft., and one water compartment 5½ ft. by 12 ft., was sunk a depth of 335 ft. cutting the Holmes vein, 15 ft. thick, the Four Foot vein, 5 feet thick, the top split of Mammoth vein, 18 ft. thick and the middle split of Mammoth vein 12 ft. thick. Gangways were immediately opened in the middle split of the Mammoth vein, and driven east and west and tunnels started from them north and south, to the underlying and overlying veins. Since that time if any colliery in the Schuylkill region was in operation, Ellangowan was also, except in case of serious accidents, which have been very few during the thirty-five years that the colliery has been in operation. The most serious accident, financially, was the total destruction of the breaker by fire, on January 5th, 1878, fortunately however no person was injured.

The sinking of the shaft was commenced in what was termed at that time a novel way, but just such ideas have undoubtedly lead to the present improved rock drilling apparatus. A strong horizontal frame was constructed of 18 inch square timber over the head of the shaft, on which heavy iron girders, with slots, were bolted. The drilling machines were fastened to these girders by clamps, and holes for blasting drilled to any desired depth. When one hole had been drilled the necessary depth, the machine was moved along the girders to the point desired for the next hole, and in a short space of time was again ready for operating. There were three of these iron girders and twice as many drilling machines, so that the work could be executed as fast as desired or possible. At the point where the shaft was sunk, the wash and other soft measures contiguous thereto, continued to a depth of 30 ft. below the surface line. To prevent too heavy a strain on the shaft timbers proper, and make as secure a job as possible, 12 inch round timbers were placed skin to skin outside of the space required for the regular shaft timbers, to a depth of 35 ft. Inside of these round timbers the shaft timbers proper, 12 inches square, were placed skin to skin, to a depth of 30 feet; below this point they were set at 3 feet from center to center and continued at that distance to the bottom of the shaft, except in places where more soft measures were met, when the timber was again set skin to skin.

The plan of shaft timbers near surface is shown in Figure 2. On the shaft level, the tunnels driven north cut the bottom split of the Mammoth vein, the Skidmore, Seven Foot and Buck Mountain veins, and the tunnels driven south cut the top split of the Mammoth vein, the Four Foot, Holmes, Primrose and Orchard veins.

A plane 100 yds. long was driven from the Shaft Level east top split gangway, and on the level thus opened, tunnels were driven north to the underlying veins.

Owing to the extreme lift from the shaft level to the water level, in the veins above the top split, and the fact that it would require several planes or counter shutes to work it, a single track slope, 12 foot spread, 8 foot collar and 8 feet off of rail, was sunk from the surface, in the Holmes vein, to the shaft level, a distance of three hundred and forty-one (341) yards. From this slope three lifts were turned, east and west, and where the lifts were of such a length that the coal could not be worked advantageously, counter gangways were driven about midway between the lifts. On the second lift of the slope, tunnels were driven south to the Primrose and Orchard veins.

From these tunnels, on different levels, two gangways

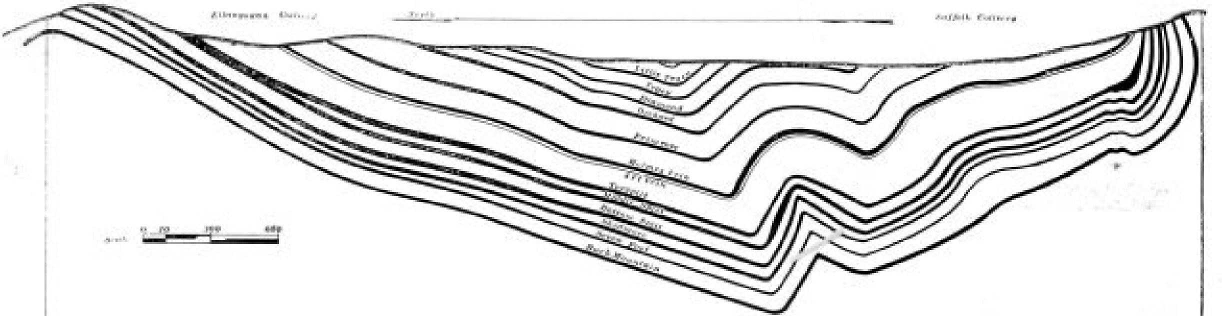


FIG. 1.—CROSS SECTION THROUGH ELLANGOWAN BASIN.

were opened in each vein, one east and the other west so that the colliery was a mammoth one from the time the company took charge and began shipping.

Some idea of the magnitude of the operations can be formed when we consider:

1st. The veins worked cover a surface area, separately of 32,000,000 square feet, or nearly 600 acres.

2d. The extreme run east and west is nearly 3 miles.

3rd. The aggregate thickness of the different veins worked is one hundred and twenty-five (125) feet. This

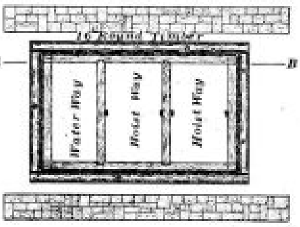


FIG. 2.

is not counting the same vein on different levels, but all the veins on one level.

4th. There are over thirty (30) miles of gangways, through which coal is passing every day that the colliery is in operation.

5th. There are 1390 yards of tunnels through rock and slate, connecting the different veins on the various levels.

6th. There are over 900 men and boys, employed in and about the colliery.

7th. Coal is being mined in 41 different gangways.

8th. Eight hundred and eighty wagons of coal (of 2½ tons each) have been dumped into the breaker in one day of ten hours.

There are few collieries where such a diversity in the methods of mining is necessary. While our section shows a comparatively even and regular pitch (which is the case on the line of shaft where section is taken), yet in the large territory covered by the workings there are possibly as many changes in the character and pitch of the veins as there are veins.

In order to fully demonstrate the different methods, we have thought it well to take them separately, and by plans, sections and brief remarks, make them so plain that their advantages for the particular pitches and veins in which they are used can be readily observed.

Fig. 3 shows one method which was used where the dip of the vein was about 20 degrees. An ordinary shute 3 yards wide was driven from the gangway to the first or "stump" heading, where it was widened out to the width desired for the breast. In veins where there is little refuse and no explosive gases they have no gob, and the sheet iron, which is necessary on this pitch, was continued up the center of the breast, and the coal from the face and sides easily diverted to it. The plan, however, shows a gob, as it can be more readily understood how the breast would be worked without the gob.

The first heading is usually 8 or 10 yards from the high side of the gangway, is driven with the gangway and used as a return airway to the first working breast

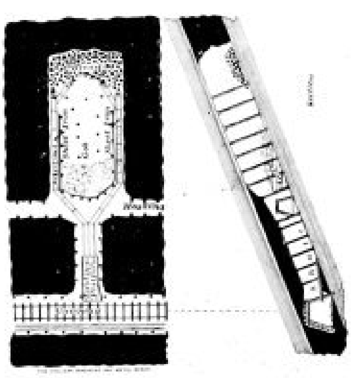


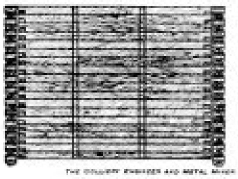
FIG. 3.

(counting from the face of gangway), where the air is turned and passes up the breast to the heading nearest the face. Through this it passes to the next breast outside, and so on until it reaches the main return airway. These headings, which are about 6 ft. wide by 5 ft. high, are driven every 15 or twenty yards above the first heading, and when a new one is completed, the next below is bratticed so as to insure a free circulation of air at the face of breast.

Fig. 4 shows another method, which, owing to the light pitch on the levels now working, is used considerably. This method is considered necessary where the pitch is too heavy to run the mine wagons directly into the breast, and too light to carry the coal on sheet iron shutes. It is termed amongst anthracite miners a buggy breast.

The shute is opened in about the same manner as described in the preceding method, but when they are ready to open or start working the breast, it is necessary to construct a running shute from the gangway to a point available for a dump. From here a narrow-gauge track is laid, usually in the center of the breast, and extended as the driving of the breast progresses. The space on either side of the buggy track is used as a depository for any refuse which can be readily removed from the coal. There are quite a number of breasts at this colliery in which the pitch of the vein is regular for 30 or 40 yards, when it suddenly increases so much that another shute has to be constructed and a second buggy used on the light pitch which comes in above; in fact, there are some breasts at this colliery in which three buggies are necessary before the coal reaches the mine wagon on the gangway.

Section through A B



The ventilation of these breasts is accomplished in the same manner as that described in the preceding method.

Figure 5 shows a "wagon breast," or a breast in which the regular mine wagon is run directly into the point of work: this method is used very little at present but was necessary a few years ago in the extensive flat in the east Holmes vein working. The breast is turned from the gangway with an easy curve about 16 ft. radius, and driven about 4 yards wide to the first heading, where it is widened to the full breast width 8 or 10 yards, according to circumstances. The plan shows the wagon track thrown to the left after entering the breast proper, the reason for this is obvious, as what little dip the vein has is naturally in that direction, and being the lowest point in the breast is the best location for the track. Ventilation is procured by using the gangway as the inlet and the headings and breasts as the outlet. Doors are placed in the breast at the high side of the gangway, abandoned headings are bratticed with sail cloth or boards and in this manner an uninterrupted current of air is secured.

In Fig. 7 we have an entirely different method from any of those already described. This method was used in the shaft level Bottom Split and Top Split gangways, where the average dip of the vein was forty-five (45) degrees. It consists of a breast with two shutes, the gob in the center and headings every 15 or 20 yards. Where the amount of refuse in the vein is small and does not accumulate fast enough to keep the gob well up to the face of the breast, strong batteries are constructed near the face, 5 or 6 ft. high, at right angles to the pitch of the vein, and the refuse is thrown over the top of them to the gob below. These batteries afterwards serve as a stopping for an additional gob as the breast advances. These breasts are ventilated by the air passing up the inside shute to the face of breast, and down the outside shute to the heading nearest the face, thence through this heading to the next breast outside and so on to the main airway. It has proven a very satisfactory method of ventilation.

In the western part of the basin in the counter or upper levels, the Middle Split of the Mammoth vein and the Bottom Split of the Mammoth vein were so close to one another, that it was inexpedient to drive a gangway in both veins, and yet the slate separating the veins was so thick that it was considered impracticable to mine both splits together and prevent the slate becoming mixed with the coal, at a reasonable cost. After a consultation amongst the officials of the mining department it was decided to experiment with the method described in Fig. 6, which proved very successful and was continued.

The gangway was driven in the Bottom Split, breasts with two shutes, as described in Fig. 7, were driven

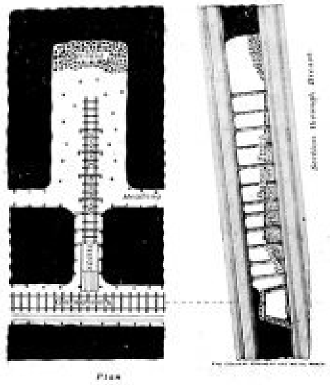
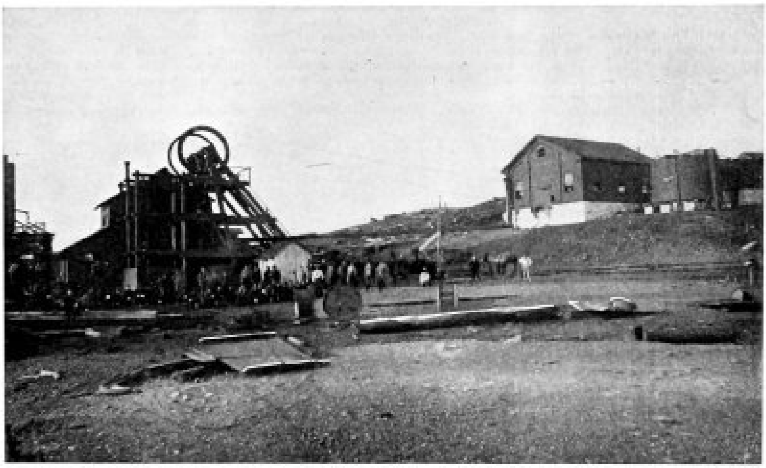


FIG. 4.

from it, and the Bottom Split coal mined in that way. On the opposite side of the gangway, midway between these two shutes, "back" shutes were driven, on a pitch of about 30 degrees, through coal and slate, to the bottom slate of the Middle Split vein; from the head of these back shutes, narrow shutes were driven on the bottom slate of the Middle Split, until they had passed the gangway and shute in the Bottom Split vein below, when full width breasts were opened, and the breast continued as described in Fig. 3. Ventilation of these double breasts was readily obtained by splitting the current of air at the face of the gangway, and allowing part to pass out through the Bottom Split working as previously described, the other part passing through the last back shute to the Middle Split breasts and on out to the return airway.

Few collieries have presented such varied experiences in the mining of anthracite coal, and it has well been said, "that an honest and faithful man who had spent the greater part of his time in the different official capacities at Ellangowan colliery was a desirable man for any coal company to have."



ELLANGOWAN COLLIERY SHAFT-HEAD FRAME.—READY FOR START, 6:30 A. M.

The following table, shows the production in tons at this colliery from 1869 to 1894.

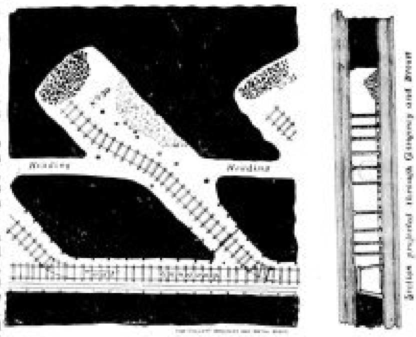


FIG. 5.

1869	Produced	29,000	Tons
1870	"	34,000	"
1871	"	50,290	"
1872	"	76,410	"
1873	"	70,615	"
1874	"	65,730	"
1875	"	53,985	"
1876	"	91,885	"
1877	"	145,866	"
1878	"	2,003	"
1879	"	17,240	"
1880	"	187,261	"
1881	"	210,877	"
1882	"	258,749	"
1883	"	312,590	"
1884	"	318,377	"
1885	"	371,721	"
1886	"	475,613	"
1887	"	459,335	"
1888	"	418,545	"
1889	"	458,090	"

1890	"	416,585	"
1891	"	389,065	"
1892	"	347,000	"
1893	"	319,400	"
1894	"	284,900	"

Total production 1869 to 1895 ...... 5,845,990 Tons

* January 5th, 1878, the breaker was totally destroyed by fire, and rebuilding was not completed until near the close of 1879.

The reduced shipments for the last five years are attributable to the forced suspension made necessary by the general restriction in output, in the anthracite coal trade.

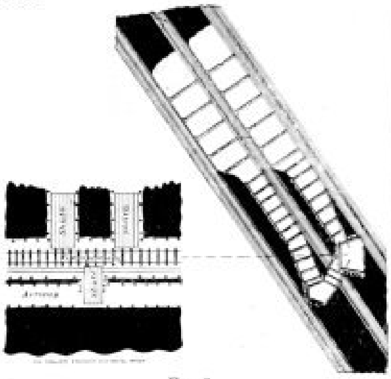


FIG. 6.

The P. & R. C. & I. Co. has stood faithfully by its agreements, not to produce more than a certain percentage of the entire output, and this colliery like all their others was reduced to one-half and three-fourths of the usual working time.

The demand for this coal is such that the colliery could readily have worked full time had they been allowed to do so.

Such an extensive operation with its numerous connections to workings on higher levels, especially in the

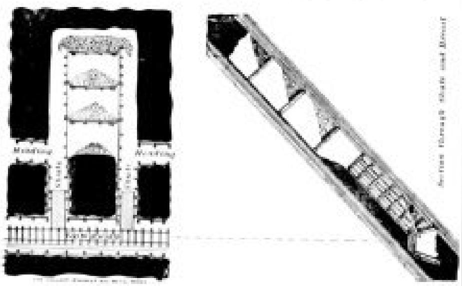


FIG. 7.

western portion, where it is connected with the famous Shenandoah City colliery strippings, naturally collects an enormous amount of water, but the officials have wisely provided for all such contingencies and have ample pumping machinery in position to handle a vast amount of water.

The apparatus consists of two (2) large bull pumps, one with steam cylinder 50 inches in diameter, water cylinder 20 inches diameter and a stroke of 120 inches, having a capacity of 1,173,600 gallons per twenty four hours; and another with steam cylinder 55 inches in diameter, water cylinder 24 inches in diameter and a stroke of 120 inches, having a capacity of 1,692,000 gallons per twenty four hours.

These bull pumps are located over and in the water compartment of the shaft. A view of the large steam cylinder and its connections is shown in Fig. 11.

There are also in place in the pump room, driven in rock at the foot of the shaft, three standard P. & R.

FIG. 8.—VIEW OF SURFACE ARRANGEMENTS FOR HOISTING ON INSIDE SLOPE. ROPES PASS OVER THE SHEAVES AND DOWN BORE-HOLES.

C. & I. Co. 9″ × 38″ pumps, with steam cylinders 18 inches diameter, water cylinders 9 inches diameter and 38 inch stroke, each pump having a capacity of 1,152,000 gallons per twenty four hours.

This gives us a combined pumping capacity of 6,321,600

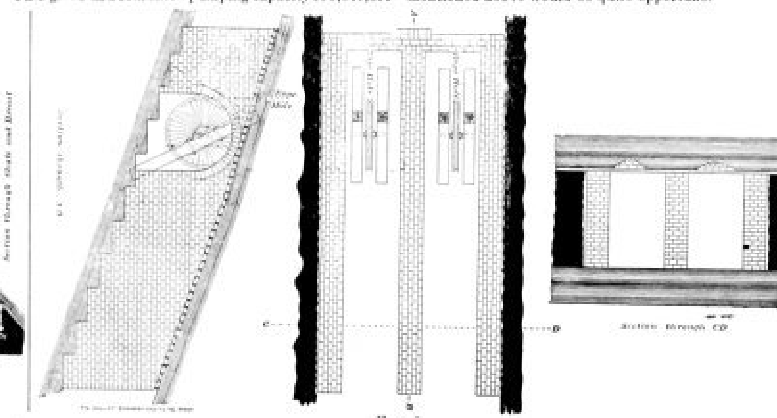


FIG. 9

gallons per twenty four hours with the pumps running at a mean speed; if forced they are easily capable of pumping 20 per cent. more per day.

In addition they have provided two iron water tanks with a capacity of 600 gallons, which in emergencies are used in the hoisting compartments of the shaft; considering that the hoisting engines are capable of hoisting one of these tanks every fifteen seconds, and allowing twenty-five seconds for filling and emptying, we have 1,296,000 gallons per twenty four hours. They have also furnished a large tank, with a capacity of 1,600 gallons for use on the slope, which can deliver on the surface 576,000 gallons of water in twenty four hours; summarising, the apparatus in position and on hand, ready for use, is capable of discharging on the surface 8,193,600 gallons of water every twenty-four hours. It may seem impossible that such an amount of water could collect in one colliery, but such is the case, and at times with all these appliances it was barely possible to handle the water as fast as it accumulated.

Right here a few remarks on the 9″ × 38″ pumps mentioned above would be quite opportune.

These pumps are used at all of the P. & R., C. & I. Co. collieries, were designed and constructed at their extensive and well equipped shops at Pottsville, Pa., and for simplicity, durability and effectiveness have few equals in their class.

They are so simple in construction that any person with a slight idea of mechanics can put them together, run them and keep them in repair, so durable that they will last as long if not longer than the most expensive pumps, and so effective that when in good condition, as regards packing, etc., they have been submerged for periods of ten days to two weeks and continued running as smooth and regular and delivered as much water as ever. When the water had been lowered enough to reach the pumps, the pistons were re-packed, a few slight repairs made and the pumps started up again.

Having now traversed the inside or mining portion of the colliery, as briefly as consistency will allow, we will now follow the coal from the shaft and slope toward and to the breaker. Once landed on the surface, the loaded mine wagons are run by gravity to the foot of the car hoist or plane, shown in Fig. 10, which has two tracks for hoisting the loaded wagons or cars, and one track for lowering the empty cars. The loaded cars are hoisted to the top of this plane, close to which the breaker tip or dump is located, dumped and then returned by gravity to the empty track of the plane, lowered and distributed to the shaft and slope.

This plane is supplied with three endless car hoist chains, one for each track, with hooks or catches at convenient distances, which take hold on the axle of the car, so that cars can be hoisted or lowered at most any time desired, as the machinery running the chains is connected to the breaker engine and is in constant motion while the breaker is in operation.

The coal having been dumped into the breaker, the preparation for market now begins, and this colliery, like nearly all the Reading operations, has the reputation of shipping some of the best prepared coal.

To follow the coal in its different courses through the breaker, we fear would become too tedious to most readers, so we will described the breaker machinery, etc., as briefly as possible.

The breaker is 130 feet long, 90 feet wide and 55 feet high from the rail at loading shutes, shown in Fig. 12; and is fitted out with all modern machinery for the prep-

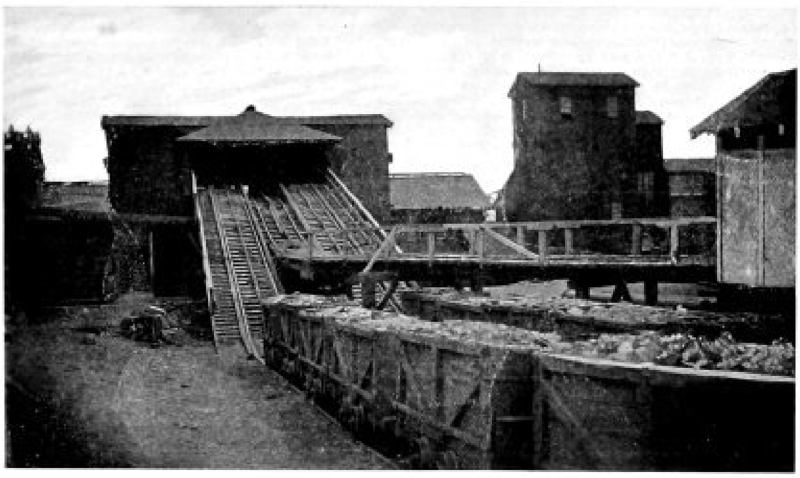


FIG. 10.—CAR HOIST ON PLANE TO BREAKER TIP.

aration of anthracite coal, some of which is: 4 sets rollers, from 22 to 36 inches in diameter and from 30 to 52 inches long, 8 screens 5 feet diameter 12 feet long, 2 screens 5 feet diameter 9 feet long, 4 screens 4 feet diameter 6 feet long, 12 wooden jigs with scrapers, etc., complete, 9 sets of coal and slate elevators, and all other necessary appliances, all of which are run by an engine with an 18 inch cylinder and 60 inch stroke.

In addition to the breaker there is a separate jig house, 53 feet long, 41 feet wide and 40 feet high, which contains 8 wooden jigs, 9 screens from 4 to 5 feet in diameter and from 6 to 13 feet long, and 2 sets of elevators 50 feet long. This machinery is run by an engine with cylinder 16 inches diameter and 34 inch stroke.

The breaker, jig house and all other colliery buildings are heated by steam, which requires nearly 3,000 ft. of gas pipe from ¾ inch to 4 inches in diameter, and 3 large heaters 30 inches diameter by 30 feet long. These heaters are used in the breaker where an extensive heating surface is necessary.

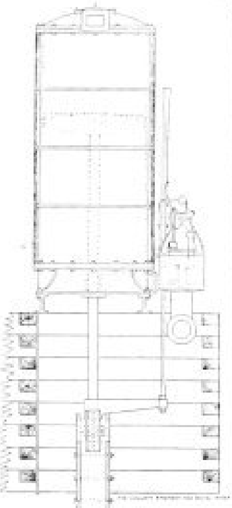


Fig. 11.

The steam generating plant consists of 8 tubular boilers 72 inches diameter by 18 feet long, capable of producing 180 horse power each, also 18 cylinder boilers 34 inches diameter by 30 feet long, which can furnish 30 horse power each, or a combined capacity of 1,980 horse power. The latter, or cylinder boilers, are gradually being replaced by the tubular boilers, which are superior in many ways, although the old cylinder boiler had its advantages, the principal one being that during the droughts, so general in the coal regions where nearly all neighboring springs are destroyed by breaches and crop falls, the acidulated water discharged from the mines could be purified cheaply to such a degree that it could be used for steam purposes in these boilers, but then there was constant danger of neglect in the proper purification of the water, and the company has undoubtedly pursued a wise and economical course in gradually replacing them with the more modern tubular boilers, which are capable of producing a greater per cent. of power per ton of fuel consumed. This change, of course, necessitates an adequate supply of pure spring water, which is furnished by the Anthracite Water Company from their reservoir on Waste House Run, a few miles north of Ellangowan. To meet the increased demand, this water company has laid during the summer of 1894, nearly 7,000 feet of 10-inch hautboy pipe, connecting their reservoir with those of the Mahanoy City water company, which owns several reservoirs, and in addition have a pumping station in the Catawissa Valley on Messer's Run and Nigger Run, which can furnish a supply almost inexhaustible.

To close this article without making mention of the improvements now in progress and the future prospects of Ellangowan, would be unjust alike to the reader and the company.

During the past year or two the slope was extended below the shaft level a distance of 110 yards, to develop a new lift, which, by the way, is Ellangowan's limit in the basin, this slope will be used as a tender slope for men, feed, timber, etc. A double track slope for hoisting coal has also been sunk to this level, which is now completed and in operation. On this new, or 5th lift, gangways are driving in the Holmes vein (14 feet thick) east and west, and a tunnel has been started from the west Holmes gangway toward the Buck Mountain vein, which it is estimated will be cut at 400 yards. The tunnel has already cut the Four Foot vein, 5 feet thick, the Top Split of the Mammoth vein, 12 feet thick, and the Middle Split of the Mammoth vein, 12 feet thick, and will cut veins aggregating 43 feet in thickness. Considering the run east and west and that the veins will yield 50 per cent., which is a low estimate for this colliery, we have 5,050,000 tons yet to be produced from this level alone. Estimating that the coal remaining unmined in the upper lifts will yield fully as much, gives us in round numbers 10,000,000 tons to be produced from the whole colliery; then taking an average production for the past five years, we find that Ellangowan colliery will have coal enough to continue operation 25 years more, or a total of 60 years since it was first opened.

In our estimate for the new lift, we have not considered any veins above the Holmes as they are reserved for Maple Hill colliery on the south.

A word in regard to this new slope: When it was decided to open the new lift it was first proposed to extend the present slope, with a double track, then widen the entire length above the shaft level and have a double track slope from the surface to the new lift and take the coal to the surface through this slope.

This plan, however, has so many disadvantages that it was finally abandoned and the single track slope extended, and provision made for a double track underground slope from the shaft level to the new lift. After selecting the most available location, a narrow shute was driven on line of the proposed slope from the new lift to the shaft level. After this the slope was started from the shaft level, and this chute was used to convey the coal excavated for the necessary width of the slope, to the gangway below, so that no engines were required in the sinking of the slope. The timber was lowered from the shaft level as needed by an ordinary hand crane and hemp rope.

For various reasons it was deemed advisable to place the engines for this slope on the surface, and bore holes 8 inches in diameter were bored from the surface, with a regular oil well drill rig, and so accurate the surveys, that the deviation from the point desired in the mines, was scarcely noticeable.

In one hole, 4 inch oil well casing was placed and enclosed with sand and cement, this pipe was for one rope. In the other hole, 4 inch oil well casing for the other rope, 2 inch gas pipe for speaking tube, and 1½ inch gas pipe for signal wires, were placed and the whole enclosed with sand and cement. A view of the engine house and sheaves for this slope are shown in Fig. 8.

When the holes were completed, and the landing of the slope on the shaft level nearly completed, it was found that owing to the pillars in the immediate vicinity of the slope being very narrow there were indications of a "squeeze" or settling which if allowed to continue might eventually ruin the bore holes and damage the entire slope. As the heavy timber already in place gave evidence of the heavy strain it was decided to build brick and cement walls, and to use steel T rail for laggings to support the roof, this was done and so satisfactory were the results that we show in Fig. 9 how the walls were constructed.

In closing, the writer wishes to acknowledge the courtesies extended by Mr. R. C. Luther, Gen'l. Sup't., Mr. Geo. S. Clemens, Division Engineer and Mr. John H. Pollard, Assistant Engineer in charge.

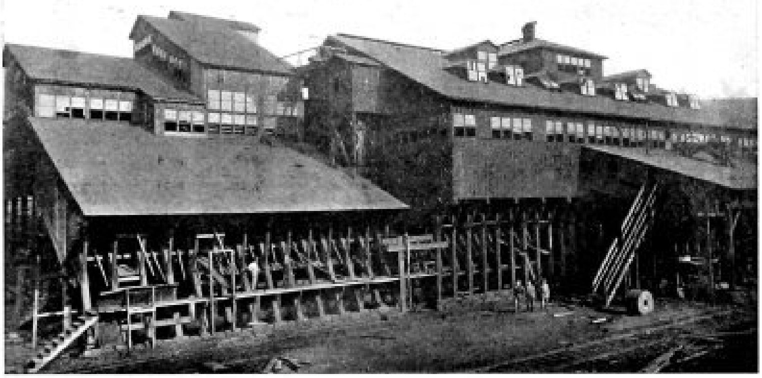


Fig. 12.—Loading Shutes at Breaker.

The Otto-Hoffman Retort Coke Ovens.

We have received from the Otto Coke and Chemical Co. of Pittsburgh, Pa., an exceedingly handsome illustrated pamphlet descriptive of the Otto-Hoffman Retort Coke Oven System, which is as much a treatise on the coking of coals of various grades and the saving of by-products as it is an advertisement of the Otto-Hoffman oven, which has met with such marked success on the continent of Europe. Every coke maker or prospective coke maker should read this work, which is sent free on application to the company's office, Lewis Block, Pittsburgh, Pa.

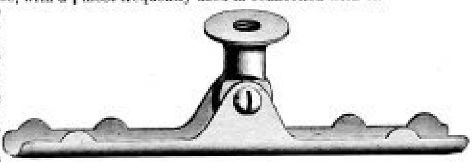
Surveying Instruments.

We have received from Messrs. F. C. Knight & Co., of 400 and 402 Locust st., Philadelphia, a copy of their latest catalogue of engineering and surveying instruments and materials. Messrs. Knight & Co. are successors to the late Edmund Draper, whose instruments won world wide renown for simplicity and efficiency. The instruments now made by this firm combine all the best features of the Draper instruments with many marked improvements. The catalogue which is a handsome publication is sent to any address, free on application.

A New Type of Mine Insulator.

The Ohio Brass Co., of Mansfield, Ohio, as will be seen by their advertising space on page III, are manufacturing and putting on the market, a new device for the suspension of trolley wires in mines.

The accompanying cuts show views of this mine insulator as well as the Jewell Trolley Sling, which is most frequently used in connection with it.



The mine insulator consists of an outer covering of either bronze metal or malleable iron, which is provided with means for attaching it directly to the roof of the mine by means of lag screws or bolts. This affords a very thorough protection for the insulating material inside of it, and effectually prevents any moisture from reaching it from the overhead drip.

This insulator is also designed in such a manner that there will be no surface leakage of the current, due to coal dust or other conducting substances settling upon it, and its construction is such that the trolley wheel in passing under the hanger cannot strike against the insulator.

This insulator was especially designed for one of the largest companies which make a specialty of installing electric railway plants in mines, and is meeting with great success.

The Jewell Trolley Sling is one of the latest designs of trolley wire ears that has been placed upon the market. The wire is simply laid in the concave lip and the projecting lugs are bent down over it, no solder being required.

The lug is swiveled in the body of the ear, so that an oscillatory motion is permitted when the trolley wheel passes over it, thus preventing the pounding effect which causes so much trouble on rigid suspension.

Both these articles are listed in the new catalogue which the Ohio Brass Co. has recently put out to the trade, and we believe that not only these articles, but very many others will be found of interest to those who are interested in this class of work.

Information Wanted.

Mr. Jos. Quigley of Westville, Picton county, Nova Scotia, one of our subscribers, is anxious to know the whereabouts of his brother John Quigley, who was last heard from in Blossburgh, Tioga county, Pa., ten years ago. If any of our readers know of his whereabouts they will confer a favor by informing Mr. Jos. Quigley at the above address.

A Unique Album.

We have received from the Link Belt Engineering Co., of Philadelphia, an album of blue prints showing the scope and variety of their designs for coal handling plants. The album contains 34 views each 8½" x 6½" on fine paper, the whole being artistically bound in white flexible covers with blue title. It is one of the handsomest and most novel publications we have ever seen.

Messrs. Abendroth & Root Manufacturing Company, makers of the Root Improved Water Tube Boiler recently received a cable order for three one hundred and thirteen horse power Root boilers to be shipped to Johannesburg, South Africa. Export trade is looking up with this company.

Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING.

WHERE AND HOW TO FIND GOLD AND SILVER DEPOSITS.

Visit to the Great Leadville Gold Mine, The Ibex or Little Johnnie, and a Description of the Peculiarities of the Gold as Found.

(By Prof. Arthur Lakes, Golden, Colo.)

Leaving the town of Leadville on a sleigh, with deep snow all around us, a temperature of 17 degrees below zero, and mock suns dimly shining through the frost laden atmosphere, we drove up Stray Horse gulch with the Mosquito range on our left—a dome of snow, spotted with innumerable stumps, of what in the early days of Leadville was a thick forest of pines, just peeping above above the snowy canopy. This forest growth has long since been cut and utilized for mine timbers and for charcoal for the smelting furnaces.

On our right were steep hills and banks like sugar loaves of snow. These huge hills of debris are the crowded dumps of the older Leadville silver mine. Owing to the limited area for dumping, they have had to crib their dumps with sets of timber. After about three miles ride up the gulch, the ravine widened a little into a strip called Adelaide Park, and a little above this, a similar and more elevated strip is called Idaho Park. The so-called park is about half a mile in width, by a quarter of a mile in width.

The structure of this little strip of land is interesting and important in connection with the famous gold belt which occupies its length and breadth. It is a block of ground formed between two converging faults. The line or side of one fault is represented by the steep slope descending from the east edge of the park, down into the Big Evans gulch, and the line of the other, by the rise of Breece Hill on the west side of the park. The little valley park is dotted over with mining shafts. At the head or upper portion of the park are the shafts of the Ibex company at various distances apart. Amongst them the shaft of the far famed Little Johnnie mine. Lower down the park, the discoveries of the Ibex company at the head, have stimulated other companies to "go deep," and in several instances their shafts have found the coveted gold zone. The entire surface of the park seems to be underlaid by gold-bearing phorphyry sheets, and a gold-bearing zone.

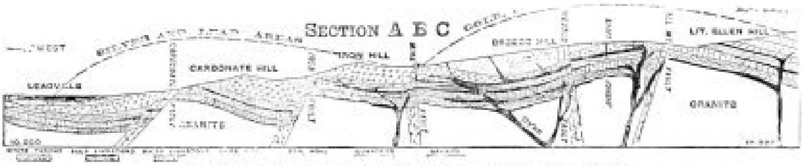
The Ibex company alone has traced its great ore body for 1,200 feet in length, by 500 feet in width. One of these porphyries is called the pyritiferous porphyry, which covers the top and lower slopes of Breece Hill overlapping the grey porphyry near the head of Idaho Park, and according to Mr. Emmons a later intrusion. A vent of it is in California gulch, and it probably extended south to Long and Derring hills, and west to Iron and Carbonate hills. The gray porphyry, through which the shaft of the Little Johnnie penetrates, appears to be between four hundred and five hundred feet in thickness, and below this again, is the ordinary white Leadville porphyry, which usually overlies or is associated with the contact silver lead deposits in the blue or Carboniferous limestone. The relation of these in the present instance, will appear in the diagram section copied from the U. S. Geological Survey Report by Mr. Emmons in Leadville, compared also with a more recent section from a different point made by Mr. A. A. Blow. In the latter the presence of younger intrusive dykes and sheets of porphyry is shown by the black lines.

To these porphyries, especially to the pyritiferous and gray porphyries, and possibly to the younger intrusive sheets, we appear to be mainly indebted for the existence of the gold belt, which lies amongst them, rather as a broad interleaved sheet, than as a narrow belt.

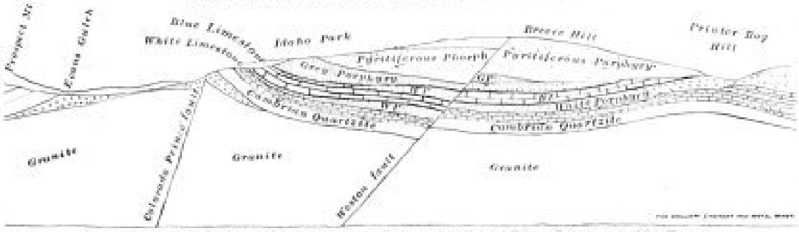
The gold ore shoot has been found locally as much as 78 feet in thickness, thinning down on either side. The ore shoot is not in an even flatshape or body, but undulates rising and falling, swelling and pinching. At the Little Johnnie mine we descended the shaft for 400 feet to the main level, where we stepped out of the "lift" and followed a tunnel through its various turnings and roundings for several hundred feet. The soft crumbling nature of the rock, together with the pressure of the hill above, require a certain amount of timbering, with upright stulls about every five feet, and lagging on the roof. The walls and roofs of these workings are all in pay ore.

DESCRIPTION OF ORE BODY.

The ore body consists of a decomposed ochreous clay, resulting perhaps from the decomposition of a porphyry highly charged originally with iron pyrites. Sometimes this reddish or yellowish clay is very stiff, and you can see the pick marks of the miners very distinctly on it; where these marks are very distinct it is a local sign of very good ore. In other places the ore body is exceedingly sandy. These sandy portions are sometimes in pockets and patches, stained with dark manganese or iron oxide; particles of quartz are numerous, and glisten like frost grains all through the ore bearing sand. This sandy material generally carries the richest ore. Sometimes in the ore body, patches of decomposed gray porphyry appear, showing their distinct spots of felspar crystals. Again, tongues of gray undecomposed porphyry come in, which some think are newer intrusive sheets intruded into the ore beds, but more probably are the original unoxidized portions of the rock. Both oxidized and unoxidized carry ore, and are shipped with the rest. In these ramifying tunnels from 7 to 8 feet in height, neither top nor bottom to the ore is shown, all is in ore of more or less value. From these levels, shafts or man-holes go up into upper levels in which large blocks of ore are stoped out. The method of timbering, whilst developing these wide thick bodies, is by series of square timber sets one upon the other. Like in a flat coal seam, after it has been excavated, the pressure from the roof is great, and in several places we saw bent or crushed timbers. As one walks along tortuous tunnels and crawls up ladders into stopes and flats, one becomes bewildered by the labyrinth. Below this upper set of excavations is a lower level, which, being wet, we did not visit, but in which we learned that some of the original undecomposed unoxidized pyrites were found, which proved to be a fairly valuable shipping ore.



SECTION THROUGH LITTLE JOHNNIE SHAFT BY MR. A. A. BLOW.



SECTION THROUGH BREECE HILL AND IDAHO PARK FROM U. S. GEOL. SURVEY BY MR. EMMONS.

Though as great a thickness as 78 feet has been found locally for the ore body, this is by no means the average thickness. In places the ore shoot dwindles down to a mere line, which may be worked and followed for some days, till it widens out into thicker bodies. They never, however, leave or lose their ore or get off its track, but follow it through all its varying thicknesses, turnings and windings. The present decomposed matter forming the bulk of the ore deposit appears to have been derived from original bodies of gold-bearing iron-pyrites, as shown in the lower level, and in the sandy or oxidized portions little square cavities are often seen, which were originally occupied by the pyrite crystals before they were oxidized out. It is a matter of some dispute at present, as to whether the ore body is a replacement of limestone at the usual Leadville "line of contact," in other words, a replacement of limestone by ore that once existed sandwiched in between two beds of porphyry, as is often observed in some of the silver lead mines of this region, or whether it is a zone of replacement and oxidation of portions of the upper gray porphyry and lower pyritiferous porphyry at about their natural line of contact. The fact that the ore body in many cases largely consists of lead carbonates, containing both silver and gold, would suggest the replacement to be that of limestone, whilst the highly siliceous character of portions of the ore body, might seem derived from a more siliceous rock, like the porphyries. Careful analysis of the ore will doubtless soon decide this point. By some, the gold belt is considered but as a distant gold-bearing prolongation of the silver-lead ore-shoots of Iron Hill, the silver-lead having by reason of a greater amount of pyritiferous and other porphyries on Breece Hill changed into a more gold-bearing product.

The ore consists of a certain amount of free gold together with bodies of carbonate of lead carrying about 50 ounces of silver to two ounces of gold, in some cases as high as eleven ounces of gold or $300 gold to the ton. So the so-called gold belt may more strictly be described as a silver-gold belt. A peculiarity of the ore is, that it contains a small per cent. of bismuth. Some of the local assayers claim that tellurides are detected in some of the gold deposits of Leadville.

The rocks containing the so-called "gold belt" dip off at a moderate angle from the the line of a great fault, and the area occupied by the present discoveries in the belt lies between two intersecting faults, the Colorado Prince fault and the Weston fault.

When the lines of these faults are met with deep under ground, despite that they represent great commotion among the rocks, and in some cases slips off several hundreds or even thousands of feet, yet contrary to what we might have expected, there is no wide gaping fissure, nor even signs of crushed broken rock. On the contrary, the sign of displacement is often only detectable by the change in the character of the rock appearing on either side of a given line, and this line is so narrow and tight, that you could not drive your knife blade into it. When this dividing line, however, is opened up, the cheeks or face of the rock on either side the fault-line are found polished as smooth as glass, by the friction of the gradual slipping movement.

At the Company's office we saw many beautiful specimens of free gold taken from this mine. One of its most striking characteristics is its peculiar flake or leaf like form. Being tarnished also with a little copper or some other mineral substance, a grey or brownish tint, like that of a dead or autumnal leaf is given to it, and a saucer full of this free gold reminds one of a plate full of grey autumn leaves chopped up a little small. These leaves or flakes issue from little cracks in the rock and stand off from it a half inch or more. At other times the rock is full of wire-gold or impregnated with specks or grains of gold. At the Carbonate Bank we saw a pile of gold bricks, some about the size of an ordinary brick, others smaller, most of them from this mine. The whole pile represented 107,000 dollars in gold. With these also were saucers full of the chopped autumnal gold leaves we have described, and marvelously beautiful masses, delicate gauze ribbons, and rosettes of crystallized gold from Breckinridge mines in the adjacent South Park, all of the bright pure yellow gold.

Despite the fact that this Leadville gold mine carries so many specimens of free gold, and despite the oxidized character of large portions of the ore, it does not appear to be a "free-milling proposition." The ore is sent to the smelter in preference to the stamp mill, as the former gives the best returns.

The soft character of the ore body, and its comparative horizontality renders its development very easy, the most important expense is that of timbering.

Nova Scotian Examination.

In our issue for June, in answering some Nova Scotian examination questions sent us by a reader, we misunderstood one question and answered it wrongly, and to make it worse, several typographical errors crept into the answer. So, to prevent our answer misleading any student, we re-publish the question and answer it correctly, giving the rule for finding the quadrant courses.

QUES. Calculate trigonometrically the bearing and distance of C from the center of the shaft in the following traverse:

No.	Angle.	Bearing.	Distance.			Remarks.
			fath.	ft.	in.	
A	0° 00′	351° 29′	10	4	8	From center of shaft.
B	90° 21′		9	3	2	
C	175° 12′		12	0	0	

From the above it is evident that the bearing from the center of the shaft to A is 351° 29′, and we will work the question out on that assumption, and assume that the graduation of the instrument is such that North is 0 or 360°, East, 90°; South, 180° and West 270°.

On page 71 of a "Treatise on Mine Surveying," by Bennett H. Brough, we find the following rule to calculate the bearing:

"To the first meridian angle add the next observed horizontal angle. If the sum exceeds 180° deduct that amount from it. If the sum is less than 180° add that amount to it. The result will be the second meridian angle, etc."

The first meridian angle is 351° 29′, or N. 8° 31′ W.

351° 29′ + 90° 21′ = 441° 50′ — 180° = 261° 50′, or S. 81° 50′ W.

261° 50′ + 175° 12′ = 437° 02′ — 180° = 257° 02′, or S. 77° 02′ W.

Sta.	Angle.	Quadrant Course.	Dist. in ft.	Nat. Cosine.	Nat. Sin.	Lat.		Dep.	
						N.	S.	E.	W.
Shaft to A	0° 00′	N. 8° 31′ W.	64.66	0.98897	0.14810	63.947			9.526
A to B	90° 21′	S. 81° 50′ W.	57.16	0.14335	0.98986		8.119		56.580
B to C	175° 12′	S. 77° 02′ W.	72.00	0.22438	0.97450		16.155		70.164
						63.947	24.274		136.320
						24.274			
						39.673			

It is shown above that station C is 39.67 ft. north and 136.22 ft. west of the center of the shaft.

Now, $\sqrt{39.67^2 + 136.32^2} = 141.98$ ft.

Now, by dividing the latitude by the departure, we find $\frac{39.673}{136.22}$, or .29124 as the natural tangent of the bearing from C to the center of the shaft. Now .29124 is the natural tangent of 16° 15′, and as C is northwest of the shaft, the bearing from C to the shaft is S. 16° 56′ E., and the distance is 141.98 ft.

Written for THE COLLIERY ENGINEER AND METAL MINER.

THE LUKE FIDLER MINE FIRE.

ITS CAUSE AND THE CONDITIONS THAT CAUSED ITS RAPID SPREAD.

A Description of the Methods Employed to Extinguish the Fire and the Difficulties Encountered in its Accomplishment.

(By Baird Halberstadt. E. M., Pottsville, Pa.)

The Luke Fidler colliery is situated about one mile east of the town of Shamokin, Pa., in the Luke Fidler basin of the Western Middle anthracite coal field.

It is operated by the Mineral Railroad and Mining Co., and together with a number of other collieries in this vicinity, is under the efficient superintendence of Mr. Morris Williams, Mining Engineer.

The operation is a large one, its shipments in 1893 amounting to 169,009 tons while employment was given to 750 men and boys.

The developments consist of a water level tunnel 2,000 feet long, cutting both dips of the Orchard and the South dips of the Primrose, Holmes, and the splits of the Mammoth coal beds.

In this basin and the Shamokin region generally the coal beds are known by numbers, beginning with the lowest bed geologically, hence the Orchard bed is called the No. 12, and the splits of the Mammoth, the Nos. 8 and 9.

Three short slopes, two of which are in rock, have been sunk from the surface. A short distance west of where the water level tunnel cuts the Holmes bed, an underground shaft (known as No. 1 Shaft) was sunk from this bed to the bottom split of the Mammoth (No. 8) bed. The top of this shaft is 150 feet below the surface. From the level of the bottom of this shaft a tunnel was driven northward some 1,100 feet to the No. 4 or Buck Mountain bed.

From the same level, two slopes were sunk on the Mammoth bed, the No. 1 Slope being 650 feet long while the No. 2 is 1,500 feet. The No. 3 Slope was sunk from water level on the Holmes (No. 10) bed for a distance of 1,000 feet.

A new shaft (see No. 2 Shaft Fig. 1) had been sunk from the surface and at the time of the breaking out of the fire, had reached a depth of 920 feet, with 45 feet yet to be sunk when it will cut the tunnel driven from the lowest gangway on the No. 8 bed.

The coal beds developed at this colliery are the Primrose (6 ft. 0 in.), Holmes (5 ft. 6 in.), Mammoth (two splits 6 ft. to 7 ft. each), Skidmore (6 ft. 6 in.) and the Buck Mountain (6 ft.). The pitch varies from 25 to 37 degrees.

The aggregate length of gangways is twenty eight (28) miles. Connections are made with the workings of the Hickory Swamp and Lancaster collieries, also with the abandoned workings of the Old Coal Run colliery.

The main fan, a 16 ft. centrifugal ventilator was situated at the mouth of the rock slope *A* which is 150 feet in length (see Fig. 1.)

The intake was from the water level tunnel and Coal Run workings. The air travelled down the inside shaft, split at the bottom, passed down the Nos. 1 and 2 slopes, thence east and west along the gangways to the faces, returned through headings and breasts to a tunnel driven to the No. 8 bed, thence by an air bridge to the air compartment in the shaft which was connected to the rock slope.

The underground shaft was divided into three compartments, two of which were used for hoisting, the third was subdivided. Through one of these sub-divisions passed the steam and column pipes to the pumps below, the other formed the return airway. The air compartment was securely bratticed off from the others with 2 inch plank which in turn were covered with floor boards.

As might be expected, the heat thrown off by the steam pipes made the brattice extremely dry: and to guard against fire, the regulations of the colliery required that in all examinations, a closed lamp or lantern should be used.

On the evening of the 8th of October last, a carpenter was ordered to examine this air box and close up such cracks and crevices as might be found. In direct violation of the rule laid down, he used a naked light, though he had a lantern with him. Passing his lamp close to a crevice, the flame from it was drawn into the air compartment and in a few moments the flames from a fierce fire reached the top, and in less than 30 minutes reached and destroyed the fan at the mouth of the rock slope and consequently the entire artificial ventilation.

The engines used in hoisting from the No. 1 Shaft were formerly underground, and to accommodate them, a room (an old breast originally) had been excavated, making a space 45 ft. x 30 ft. and 20 ft. in height. The excessive heat thrown off by the steam pipes had caused considerable scaling from the top, and to retain this, heavy cribbing had been erected. This, together with the heavy timbering on the turnouts, became easy prey to the flames.

At the foot of this shaft there were two turnouts, one 160 feet, the other 250 feet long, both in the No. 8 or bottom split bed. The slate between the Nos. 8 and 9 beds at this point, was but 10 feet thick, and as this had given away, cribbing to the height of 20 feet was necessitated over the gangway timbers on the turnouts.

As the timbers and plank, in the shaft burned away, the fire having started about midway, they fell to the bottom, setting fire to the timbering about it and extending quickly to the cribbing over the turnouts just referred to. If it be difficult to imagine, how much more so is it to describe fittingly, the spectacle presented to the gaze of the heroic miners, led by Supt. Williams, Inspector Brennan and Foremen Herr, Golden and Kohlbraker, when they advanced with pipe and hose to battle against it.

Picture to yourself if you can, a shaft of this size, the mouth of it 150 feet below the surface, heavily timbered, with these long and heavily cribbed up turnouts above and below, the whole a roaring and intensely fierce mass of fire, with flames shooting in all directions, while dense volumes of smoke, seemingly rolling and unrolling themselves, assumed fantastic shapes.

No pen can fully portray the awfulness of the scene. It can be likened only to a veritable Inferno. When the fire broke out some sixty men and boys were at work in various parts of the mine, and to rescue them alive was the first care of the officials.

Volunteers were called for and a number sufficient to form three relief parties responded.

One party descended the new shaft, another gained the interior through the old Coal Run workings, while a third passed down the timber shaft and slope, high up on the hillside, north of the colliery. So successful were these parties that all but two men were reached; two others found were directed how to escape, but, leaving the relief party still pushing forward, they evidently became bewildered and lost their way, as they never reached the surface.

To the first alarm the city firemen responded and rendered valuable aid in saving from destruction the buildings in the vicinity of the mouth of the rock slope, out of which the flames were shooting 50 feet into the air.

Upon the removal of the underground shaft engines, some time previously, they were replaced by engines on the surface, and rope holes (8 in.) were drilled through the intervening space. Down through these holes all the water it was possible to obtain was run.

While the relief parties were still searching, two 3-inch lines of gas pipe were run down the new shaft to the No. 1 inside slope and up this to as near the bottom of the shaft as possible.

These lines completed, the water was turned onto the fire, but, powerful as these streams were, they seemed to have but little effect, except to make it seemingly burn more fiercely, due, no doubt, to the fresh current of air carried in by the water.

An advance was made, but as the party proceeded, the smoke from the fire beyond came in on their rear, over and down from the cribbing, completely enveloping them, making the place utterly untenable and compelling a retreat.

The shaft and slopes formerly downcasts had now, owing to the intense heat, become upcasts, and through the latter came quantities of fire-damp (CH_4) which had gathered, since the stoppage of the fan, in the workings below. The only outlet for this gas was through the area now in flames. Two terrific explosions occurred, the concussion from which was so great that it was felt at points 1½ miles distant. So great became the volumes of smoke that notwithstanding the full current of air was forced against it, the gangways in the Hickory Swamp colliery soon became filled with smoke, and it was not until a battery had been erected, that this could be overcome.

The chances of a successful battle by the direct system of fighting, if they ever existed, had now entirely passed away.

There remained but one thing to do—flood the entire workings to save not only this, but other valuable collieries from destruction. Four human beings alive or dead remained imprisoned in the mine. Are they dead or are they wandering about in a bewildered condition, that was the question to be decided. If there remains the slightest possibility of their being alive, flooding can not be done. The relatives of the imprisoned ones, clinging to the hope that they might yet be alive, opposed flooding which meant sure death, had it not already come.

A consultation was held at which were present State Mine Inspectors Brennan, Stein, and Maguire, Superintendents Morris Williams and George T. Morgan and the writer. The case was fully discussed and every point was carefully weighed.

The condition of the mine when the last party of rescuers were driven back plainly demonstrated the impossibility of the imprisoned men being still alive. At the very outset Superintendent Williams stated in most unmistakable terms that he would sacrifice the entire colliery rather than flood it, if the *slightest* hope of rescue of the men alive or dead, remained. While the fire burned, the recovery even of their dead bodies was an impossibility. The conclusion arrived at was, that as every known means had been used to recover the men, and that as all hope was gone, there remained nothing to do but to save the colliery if possible. To this, all present assented.

Preparations were at once made to accomplish the desired end. Every known opening through which air could reach the fire was tightly battened down with plank and clay. It was decided to fill up the underground shaft with culm run in with water through the rope holes from the surface. A track was laid to the culm bank, pipes were run from the pump, and the house built over the sheaves together with the sheave wheels, were removed.

Four days after the fire broke out, October 12th, slushing began and was completed ten days later—to accomplish this there were dumped 2311 cars of culm weighing 4622 tons.

To drown out the colliery, the waters of Coal Run were run in through the Coal Run colliery. Two 8″ pumps, one duplex the other single, pumped in water from the creek south of the breaker, while all water that could be spared was furnished by the Shamokin Water Co.

Upon the completion of slushing the shaft, the battery in the tunnel was removed, and a force fan erected to permit an examination of the workings above waterlevel.

This examination revealed fire still burning, and it was then decided to flood these workings to a height of one hundred and twenty-five (125) feet above water level.

To do this the construction of two dams was necessary, one in the water level tunnel, the second in the new or No. 2 Shaft.

The dam in the tunnel (Fig. 3) was built at a point about 50 feet inside the No. 11 bed (see Fig. 2) of brick laid in Portland cement and was 5 feet thick. Deep notches were cut into the rock on the top, bottom and both sides of the tunnel as shown. Built into the dam were two pipes 8 inches and 22 inches in diameter respectively. The diameter of the larger pipe was reduced, at the outer side, by fittings and valve to 10 inches. Through this pipe it was possible for a man to to pass through the dam, to make examinations after the water had been drawn off, making it unnecessary to break through the dam, itself. The utility of this plan is obvious.

The dam in the shaft (Fig. 4.) was constructed at a point 200 feet below the surface to prevent the escape of water through the workings on the No. 11 bed, to which there was a water level outlet some distance west.

At the point noted, the planking on the outer side of the buntons was removed both above and below for 4 feet and placed on the inner side as shown. The intervening space was rammed with concrete to prevent the escape of water from the sides.

The lower face or bottom was laid with 3 inch plank, next 1 inch flooring laid in the opposite direction tightly joined, upon this came a second tier of 3 inch plank, then the whole was overlaid with 10 inch timber, these were braced with 10 inch timbers as shown. It will be observed upon inspecting the drawing, that two pipes are

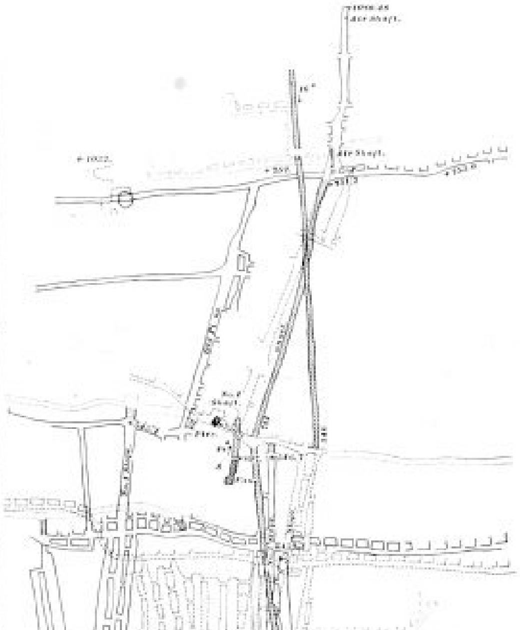


FIG. 1.—LUKE FIDLER COLLIERY, SCENE OF FIRE, OCT. 8, 1894.
DOTTED LINES SHOW WORKINGS IN NO. 8 VEIN.
SOLID LINES SHOW WORKINGS IN NO. 9 VEIN.
BROKEN LINES SHOW WORKINGS IN NO. 10 VEIN.

run through the dam. The object of these and their uses are as follows:

The smaller or 8 inch pipe extended from a point 6 feet below the dam upward to the water level where it was blanked, it was tapped with a number of holes as shown; these holes permitted the escape of air from below and prevented its compression, they also allowed the escape of a certain amount of water when it rose to these heights, and which falling upon the dam from above, assisted, by its weight, in resisting the upward pressure now exerted against it.

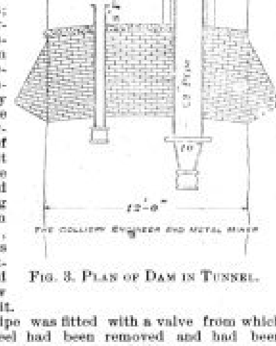


FIG. 3. PLAN OF DAM IN TUNNEL.

The 10 inch pipe was fitted with a valve from which the handle wheel had been removed and had been replaced by a pulley wheel; around this was run a rope which passed up to the surface and with which the valve could be opened or closed. Stable refuse was, as the water rose, introduced through the 10 inch pipe; this floating upon the rising water effectually closed any crack or chink if any existed in the dam.

By continuing the pipes to six feet below the dam there was less danger of their becoming clogged with floating debris, as might have been the case had they been set flush with the bottom. The upward pressure sustained by this dam approximated 1000 tons. Three months time was required to fill the workings to the desired height with water.

After a sufficient lapse of time, the water at and above water level was drawn off through the pipes in the tunnel dam. An examination was then made of these workings and not a spark of fire remained.

To remove the water from the workings below, pumps, the capacity of which was 7,000,000 gallons per diem were set to work, and in the new shaft two iron tanks with a capacity of 2,000 gallons each were placed in the hoisting ways, the valve on the 10-inch pipe was opened by means of the rope, permitting the escape of the confined water below. With these tanks 3,000,000 gallons per diem were raised and discharged. (A detailed description of these tanks, etc., will appear in a later number).

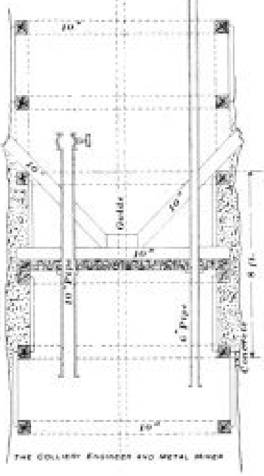


FIG. 4.—ELEVATION DAM IN SHAFT.

When the water in the shaft had been lowered to a depth which made the tanks ineffectual on account of the dam, the pumps lowered the water further, when the dam was removed, and hoisting with the tanks was resumed.

At the present rate of discharge, the mine will be free of water by August 1st. Assuming this to be so, the time required to remove the water will approximate six months.

The entire supervision of the work of subduing this, one of the fiercest mine fires the region has seen, fell entirely upon the shoulders of Superintendent Morris Williams, and he has again demonstrated that his skill as an engineer is equalled by his skill as a practical mining man.

In conclusion I wish to acknowledge the obligation he and inspector Edward Brennan have placed me under in furnishing me with data and accompanying me over the ground since the fire, as well as for numerous other courtesies.

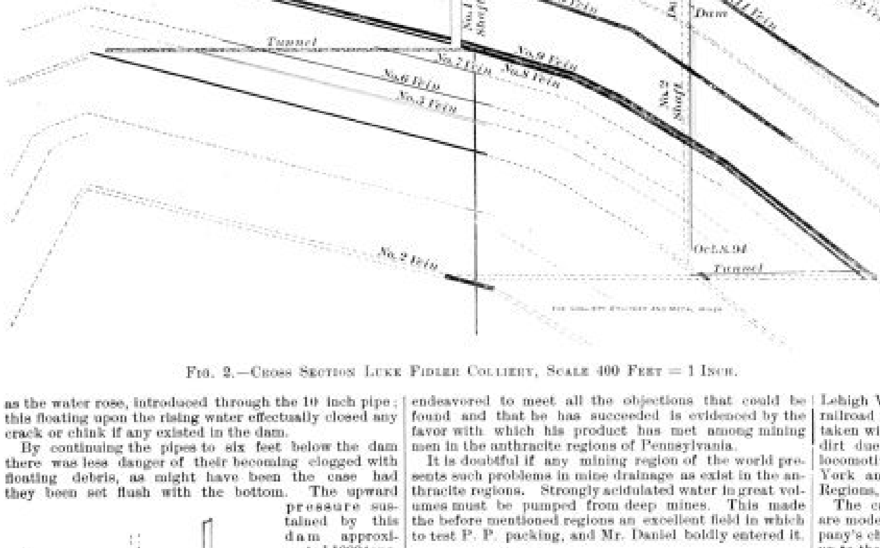


FIG. 2.—CROSS SECTION LUKE FIDLER COLLIERY, SCALE 400 FEET = 1 INCH.

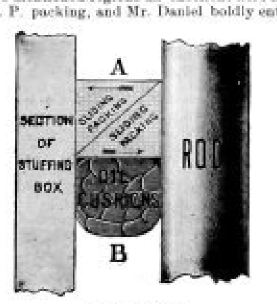
PERFECT PUMP PACKING.

Description of a Style of Packing which is Meeting With Great Success.

To say that all packings but P. P. packing have been failures in mine pumps would be untrue, but to say that they have not been unqualifiedly successful would be true. Sometimes the fault lay in the shape of the packing, and sometimes both the shape of the packing and the quality of the material used in its manufacture were to blame.

In P. P. packing, Mr. C. A. Daniel, the manufacturer, endeavored to meet all the objections that could be found and that he has succeeded is evidenced by the favor with which his product has met among mining men in the anthracite regions of Pennsylvania.

It is doubtful if any mining region of the world presents such problems in mine drainage as exist in the anthracite regions. Strongly acidulated water in great volumes must be pumped from deep mines. This made the before mentioned regions an excellent field in which to test P. P. packing, and Mr. Daniel boldly entered it.



ROD PACKING.

A glance at the above illustration shows that the packing brings into service a cushion which adapts itself to the changing position of the wedges, formed by cutting the rubber back diagonally through its section, and thus keeps up a uniform pressure. The cushion acts as a lubricant carrier.

The packing is applied by entering it, cushion first, into the stuffing box. The gland is then pushed down upon the rings and the nuts holding the gland in place are tightened with the fingers. A wrench is unnecessary, as the steam or water pressure tends to force it against the gland. This pressure slides one wedge upon the other and dilates the packing, thus adjusting it automatically. This is well shown in hoisting engines. When the engines are running forward with steam, the gland is so tightly forced on to the nuts that it cannot be moved. When they run backward without steam the gland is freely moved. In applying rings of this packing, the joints are broken, as in any other packing.

The lubricant used in the hemp cushion is of the finest grade of lubricating oil. The graphite, incorporated with the packing in its construction, has all been floated to free it from grit, and is of the finest grade. The rubber back from which the wedges are cut is a grade of canvas and rubber, which by experiment has been found to be least affected by steam, hot water, acids or alkalies. This packing has been in use for about 18 months in many of the mine pumps and other machinery throughout the anthracite region, and has been praised in every instance as something far superior to other makes.

Pumpmen, where bad water is to be handled, claim that the graphite of this packing coates the plungers of the pump with a black film that is to a large measure impervious to the action of acid water and this preserves the plunger from corrosion. The Lehigh & Wilkes-Barre Coal Co., has adopted the packing entirely and has so far given it nothing but praise. In one of their fan engines the packing gave five months and five days service and was then only removed to see what condition it was in. It was found in splendid condition. This engine has a three inch rod, badly scarred from the use of other packings. It runs day and night at a piston speed of 180 ft. per minute. For the same company, at the Hollenback mine, one of their "bull pumps" was packed with this packing. The rod in this instance weighs 7,500 lbs., and the cylinder rods are vertical instead of horizontal. Great trouble has always been experienced from condensations in the cylinder, and the squirting of water over everything near. Since packing with "P. P. P." no water leaks at all. At the D. L. & W. mines the packing has been found in their worst mine pump to give 70 times more service than the packing they were using. Mr. Townsend Poore, Master Mechanic of the company, in a letter to Mr. Storrs, claimed for it the greatest economy ever found in steam or water packings. With all others using it, the same or similar praise has been given the article. Among those using the packing as superior to all other, are the following prominent operators:

Hillside Coal & Iron Co.; (not quite through with test,) Elk Hill Coal & Iron Co.; Mt. Jessup Coal Co.; Blue Ridge Coal Co.; W. T. Smith; New York & Scranton Co.; D., L. & W. Co.; Lehigh Valley Coal Co.; J. C. Haddock; Waddell (Estate) Coal Co.; Lackawanna Iron & Steel Co.; Chamberlain Coal Co.; Simpson & Watkins; Coxe Bros. & Co.; Jeddo Tunnel Co.; Lehigh & Wilkes-Barre Coal Co.; Leisenring Coal Co.; Elliott, McClure & Co.; T. M. Righter & Co.; Midvalley Coal Co.; Columbus Colliery, (Mt. Carmel;) Newton & Old Forge Coal Co's.; Langcliffe Coal Co.; Lentz, Lily & Co.; Clear Spring Coal Co.; Stevens Coal Co.; C. M. Dodson & Co.; A. Van Wickle; Pardee Bros. & Co. Reference to any of these will be sure to meet with a very favorable answer.

Beauties of the Lehigh Valley.

We have received with the compliments of Mr. Chas. S. Lee, General Passenger Agent of the Lehigh Valley Railroad, a copy of a handsome album containing fifty photo-gravure illustrations of points of interest on the Lehigh Valley Railroad. The scenery along this line of railroad is unexcelled in any part of America, and this taken with the good roadbed and absence of smoke and dirt due to the exclusive use of anthracite coal on the locomotive, makes the L. V. a favorite route from New York and Philadelphia to all points in the Anthracite Regions, and to Buffalo, Niagara Falls and the West.

The car equipment is first-class. The day coaches are models of neatness and comfort, the Railroad Company's chair cars are fine, and the Pullman service fully up to that on any road in America. The dining car, run on trains Nos. 1 and 2 (between New York, Philadelphia and Buffalo) is a luxurious one. Meals are served *a la carte*, and passengers pay only for what they order. A simple, economical meal can be ordered, or the *bon vivant* can order an elaborate course dinner with wines. Each pays for what he gets and for no more. The service is first-class in every respect.

Merit Wins Success.

The Jeffrey Mfg. Co. of Columbus, Ohio, has during the past year run its full force full time, and for a number of months has had a large night force at work. Their present outlook is very good, and judging by the favor with which Jeffrey conveying machinery and Jeffrey coal mining machinery is received the shops will enjoy a continuance of this prosperity. The company is certainly an enterprising one and the officers manage the business in such a manner that the excellence of the Company's products and the promptness with which orders are filled wins new customers daily and clinches the trade of old ones.

"Facts."—"High Pressure."

The Babcock and Wilcox Company of New York, has earned a great reputation aside from that due to the excellence of the B. & W. boilers. It is due to the handsome and instructive books they publish for free distribution to steam users. Their annual publication "Steam" in several languages showed great enterprise and liberality. They have now issued two new special publications, one of which is entitled "Facts," and is really a history of water tube boiler construction. The other, entitled "High Pressure" deals with high pressure steam. Both volumes are handsomely bound, illustrated with remarkably fine engravings, and they are not only artistic in design but interesting as well.

Written for THE COLLIERY ENGINEER AND METAL MINER.

MINE SURVEYING.*

LATEST AMERICAN IDEAS AND MOST APPROVED PRACTICE.

Rewritten for the use of Mine Officials, Surveyors and Engineers, from Lectures Delivered Before the Students of Columbia School of Mines.

(By Edward B. Durham, E. M.)

CHAPTER V. (CONTINUED)

In the survey used for illustration, the total latitude and departure and elevation of the first point, as well as the azimuth of the back course, are known from previous survey. If now we add the latitude and departure of the first course to the total co-ordinates of the first station, we have the total co-ordinates of the second point, which is noted in its column opposite the second station. This is done for each station of the survey. Notice that when a *north* latitude is added to the latitude of a point *south* of the origin, it is practically subtracting it from the total latitude of that point. The directions east and west, or north and south have the same effect on the operation as the plus and minus signs in algebra. At station 71 the work closed for the day and everything was removed, so it was practically a new survey that was commenced the next day. Instead of repeating the station and the total co-ordinates of the survey of the day before, they can be dittoed down.

The only remaining thing to be found now is the elevation of the points. This must be done in a roundabout way, as the line of the survey was run between instruments, and not on or parallel to the stations. The calculations involved can be most clearly explained by taking the case in the example here given.

The elevation of station 49 was determined by the previous survey to be 737.71, and height of the instrument this time is + 5.03, as taken from the field notes. These are added together algebraically, giving 742.74 as the elevation of the instrument. The line of survey runs from instrument to instrument and in this case falls 14.54 feet which gives the elevation of instrument at 70 to be 728.20, the next line rose 4.23 feet making the elevation of instrument at 71 to be 732.43 when the work stopped and tripods were removed. The elevations of the points are found by subtracting algebraically, the heights of instruments from the elevations of the instruments. Thus the instrument at 70 is 3.64 feet below the point, if we subtract — 3.64 from 728.20 we have 731.84 which is the required elevation. This same method of procedure will continue throughout the survey, except where the tripods have been disturbed as at station 71. Here on resuming the survey on the following day, the instrument was set at a different height than on the first day, so its new elevation must be found by adding the height of instrument to the elevation of the point, as would be done in starting a new survey. If the tripods had been left standing, and had not been disturbed, there would have been no break in the line, and the calculations would have been the same as if the work had been done at one time.

The words "Back" and "Forward" are used to indicate that the first figures are those determined by the back survey while the second are those used in continuing the line forward. Station 72 was "temporary," as noted in the remarks column, and not having any point, could not have any elevation of point or height of instrument.

The trouble in carrying elevations with plummets would be, that there would occur just such breaks, as at Station 71, at *every* station, unless special precautions were taken to prevent it.

It is often convenient to know the co-ordinates of stations, while in the field, so after finishing the calculations on the sheets, they may be added to the note book opposite the stations. In the case of temporary points the elevation of the instrument will be all that is of importance. Also put a reference to the sheet, where the calculations can be found, on the page with the notes.

All the calculations connected with surveying involve angles and require the use of the trigonometrical functions, especially, the sines and cosines. These have to be looked up in tables, of which three kinds are in common use, viz:

1. Tables of natural functions, in using which the distance is multiplied by the function. Good tables of these will be found in the hand books and are most convenient for short calculations in the field.

2. Logarithmic Tables, which are an improvement over the first, in that all the arithmetical work is done by addition, thus: log. of distance + log. of function = log. of result, but it is necessary to open the book in three different places to hunt up the logarithms. Bruhn's Manual of Logarithms is one of the best and handiest for surveying. The tables given in many of the hand books are to small for rapid work.

3. The Traverse Tables, where in using it is only necessary to open the book once, and any calculation necessary is done by addition. The distances are given in lines and there are two columns headed sines and cosines, respectively. At the intersection of these with the line belonging to a given distance, will be found the product of the distance by the function of the angle given at the head of the page. The only one we know of that is suited for computing accurate surveys, is R. L. Gurden's "Traverse Table." The distances run from 1 to 100 and the angles cover every minute of the quadrant. The co-ordinates are given to four places of decimals. W. & L. E. Gurley quote, Bruhn's Manual of Logarithms at $2.50 and Gurden's Traverse Tables at $7.50.

In reducing radiating sights to horizontal and vertical distances, preliminary to plotting, the small traverse tables found in many of the text books on surveying will be found very useful and will give results as accurate as can be plotted.

PLOTTING.

For maps of small areas on a large scale, say to 1 to 300 feet, the protractor and scale can be used to plot the survey, but for extensive work, the errors are liable to accumulate and cause great inaccuracies. If the courses are laid out each time from the meridian, instead of from the last course, a greater degree of accuracy can be obtained. Although the protractor saves calculating co-ordinates, it does not furnish any check on either the instrumental work or on the plotting. The protractor will be a convenient and rapid way of plotting the radiating sights taken by the transit surveys and will be sufficiently accurate.

The plotting of the traverse of an important or extended transit survey, especially if the scale of the map is small, should be done by means of co-ordinates, using the protractor to check the angles and the scale to check the distances.

In plotting by co-ordinates the first step is to lay off the paper in carefully made squares, about two inches on a side, and so that each side will represent a whole number of hundreds of feet. The most accurate way to divide the paper is to draw a line through its center, and near the middle of it to construct a perpendicular to it on both sides, then from these as base lines, to construct with the dividers as large a rectangle as the sheet will take and sub-divide it into squares of the desired size. To erect the perpendicular, take a point on the center line where it is desired to have the lines cross, lay off with the dividers points at equal distances on both sides, then, with the line joining these two points as a base, construct isosceles triangles on both sides of the line, and, through their apices, draw a line, this will be the desired perpendicular and should cross exactly on the point first taken.

The squares look well when drawn in green or blue ink.

In plotting the stations, they may be laid off from the nearest corner, formed by the co-ordinate lines, by constructing a rectangle, with the dividers, whose dimensions are such, that the station will come at the diagonal corner of the rectangle from the corner of the square. The permanent stations are inked in, after checking the plotting, by drawing a small red circle about the point, with a bow spring compass, leaving the prick mark in the center to indicate the exact position of the station, and placing the station number near, also in red. (See Fig. 13.) The survey lines can now be drawn in red ink *between* the circles, taking care not to cut through their circumferences. Temporary points are plotted in pencil only, and after the detail taken from them, has been put on the map, they can be rubbed out.

After the survey lines have been plotted, the detail is added. Offsets are laid off from the traverse lines, and radiating sights are plotted with a protractor and scale. The points, obtained in either way, are then joined by straight lines and the map is ready to be inked in. The outline of the workings can be drawn in black.

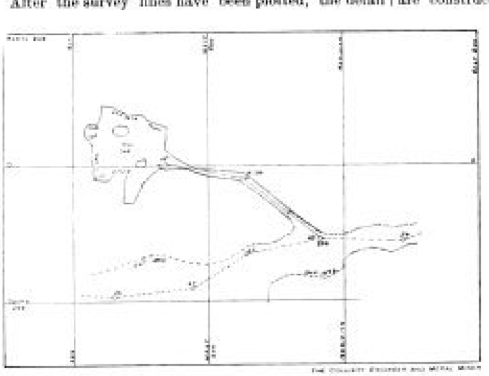


FIG. 13.—PLOT OF SURVEY.

This arrangement of colors on the map, green for the square, red for the survey lines, and black for the workings, makes a nice looking map and keeps the survey lines and construction squares in the back ground, while the outline of the workings stand out sharply. Sometimes the progress of the work from year to year, is shown by plotting the surveys made during each year in a different color, then a glance at the map will give a good idea of the area worked. Where the maps are kept up to date by frequent surveys, each one should be plotted completely and dated. Then from the plot of the original survey there will be a succession of lines showing the growth of the workings like the annual rings in trees. The area between these lines will be the area mined in the period between dates.

It is advisable to use the best, heavy, cloth mounted paper for the working maps, as they have to be handled frequently, and will soon wear out on light paper. As the paper will vary in size with the changes in the atmosphere and by wear, it is necessary that a scale should be plotted on the sheet, so that it will vary with the paper, and then new work can be plotted to the same scale as the old. Much used maps are reported as having stretched 1 to 5 feet in a 1000 feet in a few years, so in adding to old maps, care must be taken that the scale is not distorted.

A scale of 50 feet to the inch makes a very nice size for a small work, as distances can be picked off from the maps with considerable accuracy, but it would be too large for plots covering large areas.

The law in Pennsylvania requires that the working maps of the coal mines shall be 100 feet to the inch, but even this scale is found to be too large for convenience in extensive operations.

Their can be no definite rule as to the scale of the map, except that a large scale, as 50 feet to the inch, allows more accurate plotting, and more dependence can be placed on measurements taken from the map, than with smaller scales. A large scale can be used where mines are small or a large area can be readily divided so as to keep the sheets small enough to handle. A general map on a smaller scale can be made by transferring the plots of the different regions to a single sheet, by means of a pantograph.

The surface should be surveyed, and the important details in the vicinity of the workings should be plotted on the mine maps, for the mutual protection of mine and surface. Care must be exercised in mining that the ground is not so disturbed by settling as to injure the surface, or to allow water to flow into the mine. The property line must be plotted on the working map in order that ample warning may be given of the approach of the workings to the boundaries. The exact distance to the line had best be calculated, and so eliminate the errors in plotting. If a special survey is being run to determine the distance of the workings from the line, it will be convenient to use the property line as the meridian, and some point on it as the origin, then the departures of points along the face of the workings, will be their distances from the boundary. A common practice in working toward a line, is for both parties to stop mining so as to leave a wall for mutual protection. The thickness of the wall must be such that it will withstand the pressure of the overlying rocks without crumbling, and if necessary it must be able to withstand the hydrostatic pressure due to the flooding of one of the mines. The thickness of the barrier for anthracite seams can be found from the formulas given by "The Coal and Metal Miner's Pocket Book," p. 178. Width of barrier pillar = (thickness of workings × 1% of depth below drainage level) + (thickness of workings × 5). Each party should leave one half the thickness of the pillar.

Any old workings in the vicinity of the mine, must be plotted on the maps so that the excavating may not be carried too close to them, endangering the lives of the men and injuring the mine if a break is made into them, allowing gas or water to escape. In approaching abandoned workings that are liable to be dangerous, it is always advisable to drive bore holes, say 20 feet long, in advance of the excavation, as a safe guard against accident as there is no way of telling how much reliance can be placed on the old survey.

The principal plot for flat mines will be the horizontal plan and as the surveys are all referred to the horizontal, it will usually be the foundation map from which others are constructed. Elevations of points on the roof and floor should be noted frequently, in order to give some idea of the pitch of the ore body and in the case of the maps of coal mines, the dip should also be recorded accompanied by an arrow to show direction. In the latter, it is sometimes convenient to have contours of the floor, to show the formation to the best advantage. These can be drawn in from the elevations, the dips, and also by the gangways, which are usually driven on a regular grade.

Where the pitch of the ore becomes so great, that the horizontal plan is foreshortened, so that it only approximates the shape of the workings, it is customary to make a projection on an inclined plane parallel to the general direction of the deposit for the use of the mine foreman. This projection, on a reduced scale, is also used in the reports on the mine. It has the advantage of showing the workings in their true relative size, and is more intelligible to non-technical people than orthographic projections. It can be made by projecting the the distances along the strike of the ore deposit, from the horizontal plan, and using the inclined measurements recorded in the note book for the distances in the direction of the dip. The stations and traverse lines, are omitted from this plot, they being usually placed on the horizontal plan and sometimes on the vertical projection. As this incline plan or section will not be the engineer's working map, it can be projected with sufficient accuracy for its purpose. He will depend on the horizontal and vertical plans which can be made with greater accuracy.

As the pitch increases, the horizontal plan shows less and less about the mine, and the vertical projection becomes of more and more value. This is especially so when the pitch is over 45°. When the deposit becomes nearly vertical, the plan will be very small and of little use outside the engineer's office, and then the vertical longitudinal projection of the mine will be the most important guide of operations. The survey stations can be plotted by projection from the horizontal plan and by their elevations, and then the detail plotted from the survey lines by vertical offsets. Detail taken by radiating sights can be plotted as were the stations by projection and elevation.

A more accurate way, where the strike of the deposit is regular, is to take the meridian parallel to it, then the vertical projection will be in a plane parallel to the meridian and points can be located by their latitude and elevation without projecting, and radiating sights could be plotted in the same way or be projected as before.

Cross sections through a mine are often wanted, in which case they can be constructed in the same way as the vertical projection, depending also on how the data were obtained. Mr. Johnson of Longdale, Va., took cross sections through narrow chutes, in a soft hematite mine with a hanging compass.

In the case of a large mass deposit worked in floors, a general cross-section is needed to explain to others the the method of mining, and to show the arrangement of the floors and pillars. The principal working maps will be the horizontal plans of the separate floors, and each should show the pillars of the floor above, so that in leaving new pillars, they can be located so as to give the best support to the weight from above.

* Begun in March, 1895.

If there are not too many floors or levels they can all be plotted on one sheet by using a different color, or a different kind of line, for each.

This is the method used in some of the coal mines, where there are different beds, overlying each other.

If there are several floors or beds, the different lines on one map will be very confusing and it will be clearer to plot each with its own color, on a separate sheet of tracing cloth, with the meridian lines drawn on it. They can then be placed over each other in their proper relative positions for study and comparision.

This plan is often carried out much more elaborately in a glass model, by drawing the surface, and each level of the mine on a sheet of glass. These sheets are then placed in a frame at the proper distance apart so that all the beds can be seen at once in their proper relative positions. For this purpose a grade of glass known as crystal plate should be used to get the best results, as it is difficult to see through many thicknesses of ordinary glass. The plotting may be done by mixing the colors with copal picture varnish and linseed oil in proportions to flow easily and dry readily, and applying them with drawing pens and and fine brushes. A very fine model of this class was exhibited at the World's Fair, of a portion of the Copper Queen Mine of Arizona. It had horizontal plates of glass each showing the drifts of one level in its special color. These were mounted at the proper distance apart and so arranged that any of them could be slid to one side to allow the examination of those below. The nature of the rock passed through was shown by means of conventional borders to the drifts. Above the horizontal plates were arranged two sets of vertical ones, with sections through the mine plotted on them. The sections were taken both on the north and south, and on the east and west lines, at distances of 100 feet apart. The plates were suspended from overhead tracks and any or all the plates of either set of sections could be placed over the horizontal ones and be studied in connection with any of them. The sections like the horizontal plans only showed the drifts and each plate included all within 50 feet on each side of the section. The plots were all made to the scale of 50 feet to the inch.

A duplicate of this model is contained in the collection of the Mining Department of the School of Mines, Columbia College.

(TO BE CONTINUED.)

NARROW GAUGE RAILWAYS.

The Hunt System for Mining, Metallurgical and Manufacturing Establishments.

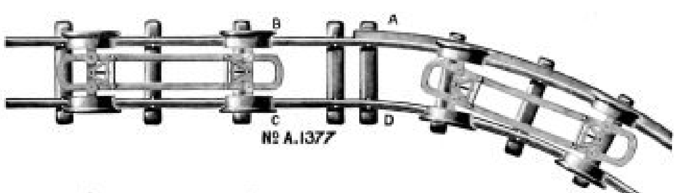
The fact that narrow gauge railways for handling and transferring coal, castings, parts of machinery and materials of all kinds in and around manufacturing establishments constitute a very important part in the economy in the operation of a plant is daily more fully appreciated, especially in a plant of considerable magnitude or where the various departments are in separate buildings. A system of cars and tracks is as much a "machine" as a lathe, a steam hammer or a loom, and should be judged in the same way. The saving in time and labor assured by its introduction, the increased dustrial establishments, is in this connection worthy of special notice.

These Industrial Railways are built by the well-known C. W. Hunt Company, 45 Broadway, New York City, who have for many years given the subject careful consideration and have acquired an enviable reputation as builders of high grade machinery of this class. In determining the gauge and the radius of the curves most suitable for an industrial railway, it is necessary to take into consideration all of the circumstances under which it is to be used.

FIG. 3.—PUSH CAR, WITH A MOVABLE CENTRE PIECE TO DUMP THE LOAD ON EITHER SIDE OF THE TRACK.

FIG. 4.—COKE CAR BUILT FOR THE TORONTO GAS COMPANY, TORONTO, CANADA.

The C. W. Hunt Company believe that if the gauge adopted by them (21½ inches measured from the outside to the outside of the heads of the rails) is not the ideal one, it comes very near to being so. In all of the railways that they have built, they have never had a user even suggest that a broader gauge would be better for any purpose.



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FIGS. 1.—AND 2.—HUNT SYSTEM OF NARROW GAUGE RAILWAYS FOR MANUFACTURING ESTABLISHMENTS.

efficiencies of other machines or of the whole works at once effected, the greater protection against damage afforded material being handled or moved, and the general convenience, must be balanced against the interest on the investment and the expense of maintenance. In putting in a railway of this kind many questions arise which require careful consideration, such as: What gauge is the best for this purpose? What radius curves should be used? How heavy should the rail be? What style of cars will be best? What kind of cross ties should be used? How shall the switches and crossings be made? Can turntables be avoided? What will be the effect of grades, etc., until it looks as though one would have to abandon his regular business to decide these details. There is however no necessity of doing this, if one determines at the outset to put in a thoroughly tried and reliable system, leaving the entire matter with all vexatious details to the experience and expert judgment of the builders.

The Hunt system of narrow gauge railways for in-

In a manufacturing establishment the curves should be of so short a radius that every part of a factory can be reached directly without expensive and troublesome turntables. The Hunt Company state, "Our standard curves are 12 feet radius measured to the centre of the tracks. This radius is almost exclusively used in manufacturing establishments where cars are usually moved by hand, because cars can be used with a running gear which runs as easily on a curve of twelve feet radius as on a straight line, the axles taking a radial position with the outer wheels running on the flange, instead of on the tread, thus enabling workmen to move double the load they could with ordinary cars. It is for this reason that we build our railways with outside flanged wheels.

"These variations from ordinary railway practice make no difference whatever in the operation of the general construction, except that the curves, switches and frogs must be especially arranged to suit wheels with outside flanges."

The load which can be carried on a railway depends not upon the gauge, but upon the strength of the track, consequently, whatever strength is needed to carry a certain load can be obtained with a narrow gauge, as readily as with the standard 4 ft. 8½ in. gauge. The Hunt cars are of improved construction, and are fitted with a flexible wheel base, the axles taking a radial position on a curve, and the wheels and the curve so proportioned that there is no slipping whatever to cause friction. This departure from the old style rigid base cars is an important feature of the Hunt system and the advantage will be at once appreciated by any one who has had experience with rigid wheel base cars.

The principle on which the cars turn a curve is illustrated in Figs. 1 and 2. A cylinder rolls on a plane in a straight line without sliding friction; a cone rolls on a plane in a circle about its vertex, without sliding friction. If both of the wheels of a car running on a curve have the same diameter as the cone would have each rail, they are portions of the cone, and the wheels would run

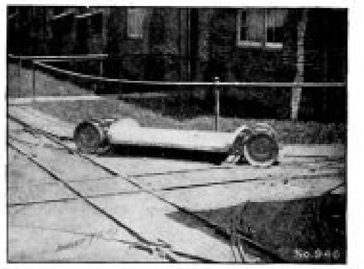


FIG. 5.—CAR FLOOR 7 IN. ABOVE THE RAILS, FOR BROWN & SHARPE MANUFACTURING CO., PROVIDENCE, R. I. THE RADIAL POSITION OF THE WHEELS ON THE CURVE IS WELL SHOWN IN THIS CUT.

around the curve without sliding friction, the axles taking a radial position. The illustration Fig. 2 clearly shows that if correctly made, there will be no sliding friction in passing the curve. In applying these principles the outer rail around the curve is made of special form so that the wheel runs on a flange instead of on the tread. The axle bearings are pivoted in the centre, between the wheels, permitting them to take a radial position, as the wheels direct.

Could the wheels be made absolutely round and exactly to the theoretical diameter, and the tracks perfectly smooth and laid to an exact circle, the cars would then pass around a curve as easily as on a straight track. It is impossible in commercial machinery to fully realize theoretical conditions, but the difference between the running gear as furnished by the C. W. Hunt Company and the ideal one is slight.

Rigid wheel base cars do not run easily around a curve because one of a pair of wheels of the same diameter, secured rigidly to the axle, must slide on the rails a distance equal to the difference in the length of the inner and the outer rail. In a car having two pairs of wheels, with the axle boxes rigidly connected to the frames, not only must this sliding take place, but it is increased by the unfavorable position in which the axles hold the wheels, as the axles cannot take a radial position, which is the one most favorable. Beside the standard cars illustrated in their latest catalogue, No. 9,504, the C. W. Hunt Company is prepared to furnish cars of special design for carrying all kinds of material, and in this system of narrow gauge railways offers apparatus embracing in its construction all the latest improvements in machinery of this class.

BOOK REVIEW.

The Modern Machinist, by John T. Usher; published by Norman W. Henley & Co., 132 Nassau St., New York. Price $2.50.

This, the latest work on machine shop practice, is written by a machinist of high standing who has had a wide range of experience both in this country and in England. The author's contributions on the subject in "*The American Machinist*" and other high grade technical publications have always been favorably received by their readers. The book contains 322 well printed pages and 257 illustrations which are strictly new, not a rehash from other works on the same subject. We notice that a large number of the cuts are perspectives, and all are well adapted to the subjects which they illustrate. Among the many subjects treated of, we notice Measuring Instruments, Vice Work, Chasing, Erecting, Lining Shafting, Planing, Shaping, Slotting, Milling, Lathe Work, etc. The book contains a copious table of contents and a good index. It should be in the hands of every person interested in the latest details pertaining to the modern machine shop.

High Grade Hoisting Machinery.

High Grade Hoisting Machinery is the title of a handsome illustrated catalogue of hoisting engines, boilers, etc., manufactured by the Pen Argyl Iron Works at Pen Argyl, Pa. The catalogue is one that will interest every mine and quarry manager. It is sent free on application to the Pen Argyl Iron Works, Pen Argyl, Pa.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.*

Questions on subjects not directly connected with mining will not be published.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following question in your valuable paper.

A mine employs 400 men and boys, and 400 mules. The amount of air for each man and boy is 100 cubic per minute and for each mule 400 cubic feet per minute. The area of airway is 8 ft. sq. and 6000 ft. long, and one-third of the air is lost through friction of the mine and fan. The fan going at 85 revolutions per minute, what is the diameter of the fan?

Yours, etc.,

Ladd, Illinois. G. H.

Ventilation and Arithmetic.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following questions in your valuable paper for some of your readers to answer.

(1.) What would be the area of an airway to pass 50,000 cubic feet of air per minute if 20,000 cubic feet is passing through one 5′ by 4′ or 20 feet area?

(2.) What is understood by the formula $(3)^{\frac{3}{2}}$? Work out and explain.

Yours etc.,

Port Morien, July 17, 1895. A. McDONALD.

Coal Dust Explosions in Lignite Coal Mines.

Editor Colliery Engineer and Metal Miner:

SIR:—I noticed an article in the June number of THE COLLIERY ENGINEER AND METAL MINER by W. S. Carr. I have every reason to think that Mr. Carr believes in the dust theory as far as bituminous mines are concerned but he doubts the possibility of such explosions to occur in lignite mines.

The purpose of this article is to prove to Mr. Carr that such explosions do occur in lignite mines in this country. On the 9th day of October 1894 an explosion occurred in one of the leading mines of the State of Washington, whereby four men were killed. The coal worked at this colliery is lignite. No fire damp was ever found before nor after the explosion. I have never met a man yet, that is acquainted with this mine, who does not believe that this was a genuine coal dust explosion. The flame could be easily traced for a thousand feet, 700 feet in a westerly direction, and 300 feet in an easterly direction from point of ignition.

Coal dust explosions occur as often in the lignite mines as in the bituminous mines, in proportion to their number.

Another example of this class of mines is the Black Diamond Coal Co., of Mount Diablo, California. An explosion occured at this mine in 1876, when eleven men died from the effects of it. Several minor explosions occurred at this colliery and to get burned was almost a sure death. There was no fire damp found in this mine either.

Yours etc.,

Tacoma, Wn., June 27. 1895. JOSEPH JAMES.

Nova Scotian Examination.

Editor Colliery Engineer and Metal Miner:

SIR:—Referring to the June number of your valuable paper and to your solution of the question from Nova Scotia, you say: "Drawing the right angle triangle *A B C* and assuming the hypothenuse *A C* as 25 feet, and the area 100 square feet."

Now I allege the forgoing construction, from any geometrical stand point, is faulty, if not quite impossible to say the least, and I wish to submit the following as being far more correct: Lay off a line *A C*, 25 feet long, and upon it draw the right angled parallelogram *A C G F* equal to twice the area of the triangle it is desired to construct.

This figure would have a width of 8 feet = to *C G* or *A F*. Upon *A C* draw a semi-circle *A B C*, and join the points *A B* and *B C*. The triangle *A B C* being in a semi-circle is right angled; its elevation *B D* = *G C* = 8 feet, and its area is 100 square feet, which fulfils the conditions of the question.

By representing *A D* by *y* and *D C* by *z* the unknown sides to this triangle are very easily and briefly calculated.

Yours etc.,

Philipsburg, Pa., June 24, 1895. A. V. HOTT.

Removing Gas.

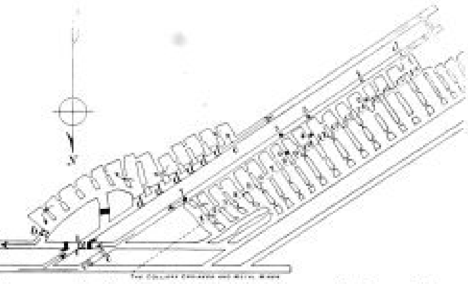
Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following in your valuable paper in answer to query given by R. R. G., in your June 1895 issue.

As shown in accompanying sketch, I would make an overcast at *a*, hung doors on places marked *d*, and at *b* would place a regulator, so that the current being split at *e*, should have a sufficient volume to diffuse the gas pent up. I would erect a door at *d* in the upper heading outside of the hole at No. 18, and would keep it open until a cross cut was made from the heading into No. 15 chamber at dot 1, when I would close the door, and open trap door at No. 18 chamber. After the gas has been removed, a cross cut should be driven from No. 15 to No. 14 at dot marked 2, and while that is in progress, a cross cut should be driven at dot 3, from heading into No. 11 chamber, and after gas has been removed, I would start a cross cut from No. 11 to No. 10 at dot 4, and while that is being driven a cross cut should be driven from heading into No. 9 chamber, at dot 5, and after gas has cleared, a cross cut should be driven from No. 9 to No. 8 chamber, at dot 6, and at the same time, a cross cut should be made from the heading into No. 1 chamber, at dot 7. After the *pent up gas* has been removed, the cross cuts, dots 1, 3 and 5, should be walled up with a strong brick wall, thus leaving but one inlet into the flooded district at No. 18. and one outlet from same at No. 1. Great care should be exercised in the selection of men for that class of work, none but well experienced men in their different callings should be permitted to work in that district.

Yours etc.,

Nanticoke, Pa. WM. H. THOMAS.



a, OVERCAST; *b*, REGULATOR; *c*, DOUBLE DOORS; *d*, SINGLE DOORS; *e*, SPLIT; ■, BRICK STOPPINGS; ● 1,2,3,4,5,6,7, PROPOSED CROSS-CUTS.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for July.

QUES. 169. Our mine is situated in a region where clean soft water cannot be obtained for feeding the steam boilers, and we are therefore obliged to get our supply from the underground feeders that are highly charged with sulphate of iron, and as you no doubt expect, the boilers last a very short time and entail on us expense that we wish to avoid if we can. One of our operators has returned from South America and he says a mine superintendent there can neutralize sulphate of iron with common salt and he thinks I should do the same. Will you then explain to me the chemical action that takes place when salt is thrown into warm water containing sulphate of iron and how it is that as the water cools sulphate of soda crystalizes on the bottom and sides of the tank; and I will also be obliged if you will explain to me the chemical action (if any) of soda sulphate on the shell of the boiler.

QUES. 170. A wealthy land owner has just granted me a lease to mine a lignite bed 10 feet thick and making an angle 70° with the plane of the horizon. The lease confers on me the right of way and the power to utilize any of the surface or underlying strata. The surface is on a bed of sand 20 feet thick and at first sight that would appear to be an unfavorable condition, but the lignite coal is good, and can secure an open market at a high price; we have however certain difficulties that must be overcome in the mode of working; for example, this coal is exceedingly subject to spontaneous ignition, and any small in the gob, or pillars left in, takes fire as soon as subjected to increased pressure. Therefore we must extract the *whole* of the coal, and I wish you to instruct me how to do it with the use of very little timber, at a small cost per ton, and with safety to the miners. To secure a good plan, think over all the modes of *vein* and *bed* mining in general use.

QUES. 171. I am the principal director of a mining company, and we have the choice of one of two mine properties, and in either of which, we could work the same valuable seam of bituminous coal at a depth of 900 feet. There are two seams of coal overlying the one we wish to work and we will call the bottom one No. 3, and the one above it is No. 2, and the top one No. 1. All the seams are lying level and their depths are, No. 1, 450 feet; No. 2, 630 feet; and No. 3, 900 feet. Between Nos. 1 and 2, is a bed of coarse sandstone that sheds much water, and in one of the offered properties *A*, the top seam has been all worked out, but in the other property *B*, none of the seams have been worked. I will therefore deem it a great favor if you will say which of the properties *A* or *B* would be the safest investment, and for what reasons?

QUES. 172. In prospecting for coal, rotary tube boring is the best, because the cores furnish fine examples of the fossils peculiar to the strata in question. This being so, will you tell me the names of some of the fossils peculiar to Permian and Silurian rocks; for example, suppose you are boring in a bed of fine shale, and the core when broken shows a featherlike fossil, made up of cells arranged in regular order, after the manner of the structures of the hydrozoa. Which formation would that shale belong to? and what is the general name of that variety of fossils? Again you are boring in a limestone, and the core when broken shows several examples of a starlike netted structure, something like a spider's web, and undoubtedly belonging to the hydrozoa, which formation is this? and what is the name of the fossil in question?

QUES. 173. For the purpose of haulage in a level seam, a branching road has to be made, at a right angle with the main entry, and we have to make the connection with a curved entrance, the radii of which are to be 22 feet for the inside, and 29 feet for the outside of the curve. Give a plan with all the necessary explanation of how you would proceed to secure the correct curvature for this junction.

QUES. 174. My Uncle George is a mine superintendent and he asked me to-day if I had given due attention to the study of mine machinery, and steam engines and boilers? and I said oh! yes, I know all about them, and nobody can teach me any more than I know; and he said, "hem," and continued, solve me this question and let me have the answer in a few days.

We have a semi-portable hauling engine in the Burdock mine, and it is rather light for the work, and therefore, always runs with full steam. It is 80 horse power, and the highest pressure of the steam at blow-off is 90 pounds on the square inch.

The train has a speed of 10 miles an hour on the level road when the steam pressure falls to 50 pounds on the square inch, and on coming within 850 yards of the shaft the train of cars has to ascend an incline, when the speed reduces and the pressure of the steam in the boilers rises to 90 pounds on the square inch. Now the boiler fire (before the start) is banked up to keep the horse power of the boiler uniform throughout the journey.

The question makes three demands:

1st. Why does the boiler pressure vary?

2nd. What is the gradient of the incline?

3rd. What is the speed of the train on the incline?

I frankly confess, I have made a mistake in bouncing to my uncle George, and I hope you will help me out of the dilemma by answering the questions for me.

Solutions to Questions which Appeared in the June and Previous Numbers, and for which Prizes Have Been Awarded.

QUES. 137. It is said you can measure the velocities of air currents in mines with a thin light pine board 2 feet deep, 1.5 feet broad, and a ¼ inch thick, and weighing 3 pounds. The board is suspended at the top corners with two pieces of fine twine, tied to the top timber. The air current blows the bottom edge of the board out of line with the plumb-line hung up close to one side of it, and the velocity is found from the pressure per square foot of the moving air. Can you tell me three things: First, is the force producing the deflections of the board, proportionate to the sines, or the tangents of the vertical angles? Second, what is the velocity of the air current to deflect the board 42°, and how would you find the angles of deflection, with only a two-foot rule for a measure?

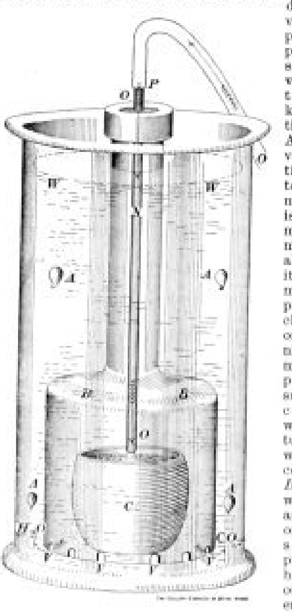
ANS. The force producing the deflection of the board is proportional to the tangent of the vertical angle of deflection, because if the surface of impingement always made a right angle with the direction of the current, the force would be proportionate to the sine of the angle, but the surface of impingement is canted, and therefore its effective surface varies as the cosine of the verticle angle and the force required for deflection is therefore $\frac{\text{sine}}{\text{cosine}} = T$.

Tangent of 42° = .900404 and $\frac{v^2 W}{2g} = F$. Now F is equal to the foot units of the force, and as the area of the board is 3 square feet and the weight of the board is 3 pounds, the weight per square foot is 1 pound, and the foot units required are $\frac{\text{Tan. } 42° \times 1.}{.076} = F = \frac{.900404 \times 1}{.076} = 11.847$. Again $\sqrt{F \times 2g} = v$, then $\sqrt{11.847 \times 64.32} = 27.605$. That is, the velocity of the current is equal to 27.605 feet per second. To find the angle of deflection measure a line from (and at a right angle with) the plumb line to the bottom edge of the board.

ADOLPHE COOK,
Houtzdale, Pa.

QUES. 157. You have given to you 23 grains of an average sample of coal, to find its evaporative power. Will you explain to me, however, before you begin, how you will proceed to do it, and further tell me how it occurs, that some samples of bituminous coal, show a greater evaporative power than some samples of anthracite coal, notwithstanding the fact that average samples of anthracite, have a greater evaporative power than average samples of bituminous coal.

ANS. To determine the evaporative power of coal, an instrument called a calorimeter is used of which the drawing is convenient for practical purposes. It consists of a glass vessel containing a known quantity of water. A weighed invariable quantity of the coal to be experimented with, is intimately mixed in a mortar with about ten times its weight of a mixture of 3 pts. potassic chlorate and one of potassic nitrate. This mixture is placed in a small copper cylinder C, which in its turn is covered with another copper vessel $B\,B$, furnished with a tube and stop-cock on the upper side, and pierced with holes V, V, V, on the lower end. A fuse is placed in the smaller cylinder containing the mixture, this is lighted, the stop-cock closed, and the apparatus let down to the bottom of the graduated flask containing the water. When combustion has ceased, the stop-cock is opened and the apparatus moved gently up and down, care being taken not to raise it out of the water. The temperature is noted at the beginning and end of the experiment, and from a table supplied with each instrument, the calorific power is found. The rise of the temperature, plus ten per cent. of this rise will give the number of pounds of water which 1 lb. of coal will convert into steam from and at 212° F. I should separate the coal given into as many parts, so that the mixture would very nearly fill my copper cylinder, the more tests taken a better average result could be found, and proceed with each experiment as given in the above description.



Some sample of bituminous coals that contain a small percentage of ash, show a higher evaporative power than some samples of anthracite coal that contain a high percentage of ash.

H. K. MOBERLY,
West Newton, Pa.

Second Prize, JOSEPH VIRGIN, Holsopple, Pa.

QUES. 158. I am a mine foreman, and the superintendent offers me promotion if I can obtain by skillful mining, all but ten per cent. of the coal in a given district that measures in plan, 200 by 300 yards. The seam is a bituminous one, 6 feet thick, and of moderate hardness; the roof stone is firm and strong but the floor is soft and tender, the under shale being as thick as the seam

Will you assist me with your advice by making it quite clear how I should proceed and be successful in working this coal at a depth of 600 feet from the surface?

ANS. I would work this coal by bord and pillar, and make the bords 120 feet long and 12 feet wide, and the headings 75 feet long and 6 feet wide. This would leave pillars having a base of 1,000 square yards, to rest securely on a *thick soft* bottom.

Having reached the boundry limits I would first commence to draw out the flanking pillars, and take great care to keep a long face on all the pillars in line, and to prevent a squeeze by subsidence into the soft bottom I would secure the face with chocks.

GEORGE BROWN,
Falls Creek, Clearfield Co., Pa.

Second Prize, H. K. MOBERLY, West Newton, Pa.

QUES. 159. I am about to try some experiments in the old workings of a certain district in a coal seam, where the coal has all been extracted and the roof and the floor have not yet broken. This vacant space measures in plan 250 by 312 yards, the area of the roof and floor being that of a rectangular parallelogram. To escape the risk of being lamed or killed, will you tell me, first, what will occur when the floor and the roof yield, after I have set up twelve props near the center of this space; second, what will take place if the coal face on all the four sides is timbered by props 6 feet apart and twelve feet from the coal face; third, what will occur if I set up back lines of props six feet apart, and twelve feet behind the face props, when the roof breaks? The seam is level; 6 feet thick, and 700 feet deep.

ANS. First, the center props will act like a buttress, and throw the weight of the cover unto the face.

Second, the row of props 12 feet from the face, will throw the weight onto the roof far into the goaf and cause a cave.

Third, the second row of props will tilt the weight over onto the coal fa e, and thus crush the side coal and and break the face props.

GEORGE BROWN,
Falls Creek, Clearfield Co., Pa.

Second Prize, JOSEPH VIRGIN, Holsopple, Pa.

QUES. 160. The main entry or gangway in a coal mine runs level along the strike of the inclined coal seam, and for facility in the haulage, a road has to be made along the pitch of a grade of 20 per cent. The junction of the main entry with the haulage road on the pitch, has to be made with a curve of 29 feet mean radius, and I will deem it a great favor if you will tell me how high the floor of the curve is above the floor of the main entry at 6 points equally distant along the line of the curve, and measured from the zero point where the curve begins in the main entry?

ANS. The six points along the curve being equidistant, will be 15° apart, then call them a, b, c, d, e and f and the point of junction, zero, then

zero to a = 15°
" to b = 30°
" to c = 45°
" to d = 60°
" to e = 75°
" to f = 90°

The heights of the different points above zero level will be proportionate to the versed sines of the angles, as

15° versed sine of a = .0340742
30° " " " b = .1339746
45° " " " c = .2928932
60° " " " d = .5000000
75° " " " e = .7411810
90° " " " f = 1.0000000

The elevation at the top of the curve will be $\frac{20}{100} \times 20 = 4$ feet, and the heights at each of the points will be in feet.

a = .0340742 × 4 = .1362968 feet.
b = .1339746 × 4 = .5358984 "
c = .2928932 × 4 = 1.1715728 "
d = .5000000 × 4 = 2.0000000 "
e = .7411810 × 4 = 2.9647240 "
f = 1.0000000 × 4 = 4.0000000 "

JOSEPH VIRGIN,
Holsopple, Pa.

Second Prize, H. K. MOBERLY, West Newton Pa.

QUES. 161. I am told that I as a professional miner should be able to identify at sight the characteristic fossils of the Carboniferous formation, and those of the formations directly above and beneath it, such as the old red sandstone and the Permian and new red sandstone. And I am dilligently seeking the knowledge required.

Some say that the fishes of the old red sandstone had peculiar tails, and they were covered with peculiar scales, will you please explain to me all these peculiarities as exemplified in four examples of the fishes of the period.

ANS. The fishes of old red-sandstone period had heterocercal tails that were vertebrated, that is the vertebral column was continued into the upper lobe of the tail, like the sharks and sturgeons in our seas now. These fishes where also placoid and their plates or scales were ganoid, that is, the horney scales or plates on the fishes had a pearly lustre.

Example 1. The *cephalaspus* of the lower series is remarkable for the great enlargement of the bony enameled plates of its head, that formed a kind of defensive shield.

Example 2. The *asterolepis* a very savage fish from 20 to 30 feet long, and coated with small placoid scales similar to the shark.

Example 3. Found in the upper series; the *holoptychius* a very large fish, distinguished for the peculiar wrinkles on its ganoid scales.

Example 4. The *pterychthys* of the upper *old red sandstone*; a remarkable fish having only *one* pair of fins, which extended from each side of the body like a pair of oars.

JOSEPH VIRGIN,
Holsopple, Pa.

Second Prize, THOS. WEST, Sherrodsville,
Carroll Co., O.

QUES. 162. How do you account for the fact that if one endless rope haulage is one mile long, and another is ten miles long, and the cars on the ropes of one haulage run at the same velocity as the cars on the other, that as many coals arrive at the shaft by the long, as by the short haulage in equal times, and with the cars at equal distances on the ropes?

While you are busy, please calculate for me the horse-power required to haul out with an endless rope haulage, 600 long tons in ten hours, the road having an upgrade to the shaft of 13 in 150, and a length of 1,500 yards.

ANS. There are ten times as many cars on the long haulage as on the short one, and the large number is moving at the same speed as the small one, consequently ten times the *number* is the exact equivalent of the small number moving with ten times the *speed*.

To find the horse-power notice that the cars will weigh as much as the coals there being two cars for one load, and taking the traction for coals, cars, and rope to be .013 of the load, and the modulus of the engine and sheaves to be .7 we thus find the H. P.

The descending cars are balanced by the ascending ones, therefore, the load only is raised, and the strain due to the grade is $\frac{600 \times 13}{150} = 52$ tons, and the strain due to traction only is, 1,200 × .013 = 15.6 tons, and the total strain is 15.6 + 52 = 67.6, we therefore find the horse-power to be

$$\frac{67.6 \times 2{,}240 \times 1{,}500 \times 3}{600 \times 33{,}000 \times .7} = 49.164 \text{ H. P.}$$

GEORGE BROWN,
Falls Creek, Clearfield Co., Pa.

Second Prize, WILLIAM DONALDSON, Kangley, Ill.

Electric Traction in Belgian Collieries.

The old horse tramway at the Amercoeur Colliery at Jumet, in the Charleroi district of Belgium, has recently been replaced by an electric tramway. The line is about a mile long, with a fairly uniform slope throughout in the direction the loaded trucks are taken of 2.7 mm. per metre, the gauge of the line being 1.64 ft. The line communicates between the Chaumonceau and Belle Vue shafts by a sloping gallery, at a depth of about 30 yards from the former, and is used for conveying the coal obtained in the Chaumonceau pit to the second-named, whence it is conveyed to the sorting plant. The first locomotive was put in use in July, 1893, and proved so successful that an order was given for a second one of an improved type. The first locomotive was designed for the haulage of 300 trucks per ten hours each train consisting of fifteen trucks, the normal speed being five miles per hour. It is 13 ft. long, 3 ft. 10 in. wide, and 3.77 ft. high. It has four wheels, and its total weight complete is 3 tons 2 cwt. 96 lb. The second one is 14.95 ft. long, 3.28 ft. wide and 4.34 ft. high, its weight being 4 tons 8 cwt. and 44 lbs. It has eight wheels arranged in two bogies, suspended on spiral springs. It was designed for the haulage of 400 trucks per ten hours, each train comprising twenty trucks, the speed being 5 miles per hour. The feature of this installation is that it is on what is known as the acumulator system, the supply of electrical energy being stored upon the locomotive, and not taken from conductors on the journey. The necessary electrical energy for charging the accumulators is supplied by the plant on the surface employed for the electric lighting of the pit bank, offices and works. It is conveyed down a service shaft by an insulated cable. Both locomotives carry a battery of Julien accumulators, comprising thirty-six cells. These are placed in ebonite boxes closed by a removable cover of the same material, and arranged in a chest on the framework of the locomotive. In the first locomotive the motor is in the center and runs at 1,020 revolutions per minute, while the wheel of the locomotive makes eighty-five revolutions per minute, so that the ratio is as 12 to 1. In this case the motor transmits its power to an intermediary shaft by means of wheels gearing in the ratio of 5 to 1, this intermediary shaft communicating with the axles of the locomotives by chain wheels and pitch chain. The second locomotive, however, has two motors, one connected to each bogey. These motors run at 680 revolutions per minute, this being reduced down by epicyclic gearing to eighty-five revolutions per minute of the wheels of the locomotive. The locomotives have platforms at each end, one of these only, however, being provided with starting and stopping arrangements, etc. Ample brake power and safety arrangements are of course provided. Unfortunately, accurate particulars as to the cost of working of the now defunct horse tramway at this time are not available, but from a careful estimate it may be put down at 1½ d. per metrical ton-kilometre. The cost of working by the first electric locomotive, works out at ¾ d. per metrical ton-kilometre, while that of the second and improved locomotive is only ½d. It may be added that the plant and locomotives were supplied by La Societe Electricite of Brussels, which concern is exhibiting a duplicate of one of the locomotives at the Antwerp Exhibition.—*Colliery Guardian.*

Coal in China.

A British consular report from Ichang states that no coal appears to have left the port during 1894, t ough in 1893, when there was seemingly less demand for it, there was an export of 10,937 piculs, valued at 3,255 taels (a tael = $1.). It is found in a number of places not far from Ichang, but the methods employed for its excavation are primitive and the mines are only workable during the dry season. When the rains set in they become flooded, and the owners have no means of pumping them free of water. No foreign machinery is employed, and, indeed, it is doubtful whether it would be tolerated by the country people, who still regard such innovations with superstitious dread. In the neighborhood of Ch'ang-yang coal is produced, some of the mines having a daily output of 30 or 40 tons of good anthracite coal. The royalty paid to the provincial government is said to be 10 tons out of every 40 tons brought to the pit's mouth. An expert in such matters, who has had long experience in the K'ai-p'ing mines, near Tientsin, gave it as his opinion recently that the country was rich in coal and only needed foreign appliances to make the production remunerative.

Did you ever stop to think why oil barrels are painted blue? Well, in making the barrels they are thoroughly soaked in water, then they are painted blue, as this is the best pigment which will hold the oil. Then when the cask is full you have oil on the ins de and on the outside with water between them, and oil won't come through water.—*Cooper's Journal.*

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AND

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APPOINTMENT OF PENNA. ANTHRACITE MINE INSPECTORS.

THE examing board for Mine Inspectors for the Third, Fourth and Fifth Anthracite Inspection Districts of Penna., has completed its work and recommended for reappointment Messrs. Hugh McDonald of the Third District and G. M. Williams of the Fourth District.

In the Fifth District, Mr. John M. Lewis the recent inspector was beaten by Mr. James Roderick who resigned the office in 1889 to accept the superintendency of Messrs. Linderman & Skeer's Stockton collieries. While the State will secure in Mr. Roderick an official who made a splendid record during his former incumbency of the office, and a man who is recognized as one of the ablest practical mining men in America, we regret that Mr. Lewis, also a very able and conscientious official loses the position. In fact, it is a pity that the State can't have the services of both the gentlemen.

In the recommendation of Messrs. McDonald and Williams for reappointment, the State will continue to profit by the services of exceptionally good men. The coming term will be the fourth term for Mr. Williams and the third for Mr. McDonald. At the close of the term, Mr. Williams will have served the State twenty years as an inspector, and Mr. McDonald will have served fifteen years.

MINING MACHINERY FOR JAPAN.

THE following note from *The Mining Journal*, (London, England) is significant:—

"The makers of mining, rock-drilling, and other machinery should be informed of an important and novel step which the Government of Japan have just taken with a view to placing the Japanese people in direct communication with manufacturers in this country of goods likely to be needed in increased quantities under the new conditions of development which are likely to result from Japan's recent notable victories. One of the earliest requirements is certain to be in the direction of largely-augmented quantities of machinery of all sorts needed to assist in the further rapid industrial progress to which there is every evidence the Japanese have made up their minds. Mining, as well as other engineering plant, will be in extended demand. Hence the advisability that our mining machinery firms should be acquainted with the course the Government have taken. Mr. E. Perrot Forshaw has been appointed by the Mikado's Government to visit this country and propound a scheme "for better inter-working between Japanese merchants and others and British manufacturers direct." All financial arrangements are to be amply secured by the chief Japanese bank. The exact details of the proposal are not yet before us, but these, will, no doubt, be available as soon as Mr. Forshaw arrives in this country. In addition to manufacturers, the Chambers of Commerce and other of our trading bodies are to be interviewed and everything is to be done to promote direct trading. Mining machinery firms should be keenly on the look-out for the earliest expounding of Mr. Forshaw's commission."

It is evident that British manufacturers will make a strong effort to control the trade in machinery in Japan. With the cordial relations existing between the United States and Japan, together with the position of Great Britain during the recent China-Japan war, when, while not actively hostile to Japan, her sympathies were certainly with China, makes the present an excellent time for American manufacturers of mining machinery to endeavor to secure a large portion of the Japanese trade. But simply sitting still and waiting for the Japanese to come to us for mining appliances will not do. Active and well considered efforts should be made to bring them here. Our consular service should be instructed to aid in the work, and the same methods used by the British to capture trade should be pursued. With the good will of the Japanese people and the best mining machinery in the world, American manufacturers possess a great advantage over those of other nations. Will this advantage to followed up?

DEATH OF JAMES LEIBERT.

WE regret to announce the death of Mr. James Leibert, formerly chief clerk for THE COLLIERY ENGINEER Company. Mr. Leibert was a gentleman in whom the officers of the company had the utmost confidence and whose business ability was of a very high order. He was the only son of the Rev. Eugene M. Leibert, a Moravian clergyman who for twenty-five years was principal of Nazareth Hall, a Moravian academy for boys (the oldest institution of the kind in America) at Nazareth, Pa.

Mr. Leibert was born at New Dorp, Staten Island, N. Y., on September 23d, 1865, while his father was stationed as pastor of the Morvian congregation at that place. He received his academic education at Nazareth Hall from which institution he graduated in June, 1878. In the fall of that year he entered the Moravian College and Theological Seminary. He took the full classical and theological course and graduated with the degree B. D. on May 16th, 1884. After completing his education Mr. Leibert felt that the theological profession was not his calling and he therefore entered Nazareth Hall as a teacher within a month after his graduation from college. He developed great talents as a teacher and exercised a wonderful control over his pupils. It was while filling this position that he attracted the attention of the officials of THE COLLIERY ENGINEER Company.

When Rev. Eugene M. Leibert retired from the principalship of Nazareth Hall his son James likewise resigned his position and accepted the position of chief clerk in this office. During the early part of the winter of 1893-4 he was afflicted with an attack of the Grippe which developed into pulmonary tuberculosis. He was finally compelled to tender his resignation and return to his father's home in hopes of therein fighting off the disease by rest and care. Everything that the most skilled physicians and the loving care of devoted parents could do was done to stay the course of the disease, but in vain. He gradually grew weaker and finally, on the evening of July 4th, he passed peacefully away. Up till within a few months of his death Mr. Leibert entertained strong hopes of recovery and anxiously awaited the time when he could return to his work.

During his comparatively brief residence in this city he won many friends and was so popular that he was elected president of the Scranton Bicycle Club, one of the strongest and most influential organizations of wheelmen in the State. He was a member of the Masonic Fraternity and took great interest in Masonic literature, land-marks and traditions.

THE PROPOSED AMENDMENT TO THE BRITISH MINING LAW.

AS Great Britian for many years led the rest of the world in coal production, she also led in the enactment of laws intended to protect life and property in mines. As a consequence other nations profited by British experience in mining legislation, and even at this time the action of the British government in regard to such legislation is of interest to American mining men.

An effort to amend the British Mine Law of 1887 has recently been made, and to give our readers an idea of the proposed changes and a discussion of the advisability of making such changes, we employed a prominent English mining engineer and colliery manager to give us an opinion on the matter at issue. The gentleman to whom this duty was assigned is a man who thoroughly believes in rational mining laws, and whose years of experience, and deep knowledge of the history of mining legislation makes him a competent person to express such an opinion.

In arriving at a correct idea as to what is required in mining legislation, the natural difficulties incident to coal mining must be carefully considered. These difficulties our correspondent enumerates as follows:

1. Operations in connection with the search for coal, and removing it when found, from its bed or seam.
2. In all underground operations, there is the superincumbent strata to be considered, and the portion of this in the immediate vicinity of the coal is a constant source of danger, and always a certain amount of cost in supporting it.
3. The presence of poisonous and explosive gases and coal dust in many mines requiring artificial ventilation.
4. The necessity for artificial lights and of such a construction in mines where fire-damp is found, as to prevent explosions.
5. Difficulties in connection with water.
6. Difficulties in connection with the haulage of the coal from the working place until it is placed in railway wagons, etc.
7. Difficulties in connection with blasting.

All the accidents which happen in or about mines arise from difficulties which are included under the above heads, except those which occur on the surface works, where the dangers encountered are not exceptionally great. For the sake of convenience they may be tabulated in the same method as adopted by the Inspectors of mines in their annual report as follows:

1. Explosions of fire-damp and coal dust.
2. Falls of roof and sides.
3. In shafts.
4. Miscellaneous underground.
5. Above ground.

It has been suggested as desirable to include in the Inspector's reports, in case of an accident, the apportionment of the blame attachable to the management and to the workpeople separately, but there are obvious difficulties in the way of arriving at this correctly, especially having regard to legal actions which might follow, under the Employer's Liability Act.

Another reason which may be given as causing a desire on the part of the people for an amended Coal Mines Bill, is the intense public feeling produced after an accident resulting in many deaths, such as the explosion at the Albion colliery in South Wales on June 23rd of last year, when 290 lives were lost. This explosion has no doubt hastened the drafting of the amended Coal Mines Bill, which deals largely with protective measures against the dangers of coal-dust and fire-damp.

Wm. Robson, the Inspector of Mines for this district, says in his annual report, in reference to the Albion explosion:

"The Albion explosion on the 23rd June already referred to, having been the subject of special reports, and these reports having been printed and published, it does not appear necessary, to refer again to it at any length. I am still convinced that it was caused by blasting timbers, at the point mentioned in the special reports, viz. near the horse-dump dip, where the bodies of the overman, fireman, and the man in charge of explosives were all found.

"Upon the matter of blasting timbers, which was undoubtely practiced at the Albion colliery, although this was unknown to my assistants and myself, I think it is due to us, as Inspectors, to state that, for at least three years previous to this explosion, inquiry was made on each occasion of a general inspection, in every mine in the district as to (1) whether blasting was permitted, (2) what kind of explosive was used, (3) what the explosive was used for (4) how and by whom shots were fired, and (5) when fired, *i. e.* during shifts or between shifts. In no case did it come to our knowledge that such a thing as blasting timber took place in the Albion or any other mine in the district. Since the explosion, roburite has been substituted for the gelignite and gelatine-dynamite previously used, and no blasting is permitted except in rock, and this only between shifts. Spray jets have been introduced throughout the principal main roads."

He further says under the head of Prosecutions:—"Proceedings, arising from the inquiry held into the cause of the Albion explosions, took place, the charges being contraventions of the 12th General Rule, against the agent and manager in allowing shots to be fired, against the manager and the chargeman for storing explosive in the mine, and against the under manager for contravention of the 42nd Special Rule, in not seeing that officers and workmen under him properly discharged their duties during the night shift. After an investigation lasting two days, the manager was convicted and fined £10-0-0 for the second offence of permitting the storing of explosives; the chargeman £2-0-0 for storing explosives, while the charge against the manager for allowing shots to be fired contrary to the Act was dismissed, as was that against the under manager on a technical point. The remaining charge, that against the agent for allowing shots to be fired, was withdrawn.

"It is perhaps hardly necessary to observe, that in a case of this kind, where every person, who could, if alive, speak as to what actually took place, was killed, the prosecution labored under much difficulty, in trying to prove to the satisfaction of a court, that shots where fired while the men were in the mine."

The opinion expressed by Mr. Robson was that held by many other experts, as to the explosion having been caused by the blasting of timbers on a main haulage road, which was ordinarily very dusty, and particularly so at the time when the shots were fired, as a number of men were engaged removing the dust, so that the conditions existing at the time were very favorable to the commencement and spreading of an explosion by the firing of a shot.

To those readers who are not conversant with the Coal Mines Act of 1887 in England, it is necessary to explain that the 12th General Rule lays down the regulations with reference to blasting. The nature of the 42nd Special Rule explains itself in the charge.

With the evidence before the jury in this case, it seems very unfortunate that the manager escaped conviction under the principal charge, viz., that of firing shots on a main haulage road, which was dry and dusty, and so long as such contraventions of carefully drafted rules escape punishment, it is to be feared that disasters may continue, although the education afforded to managers who are sceptical as to the dangers of coal dust, by the explosion at the Albion colliery, should certainly make them careful to observe the law as it at present stands with reference to shot firing under similar conditions, even although they may not share the opinions of those who believe that coal dust under certain conditions, is a highly explosive agent.

This terrible accident is mentioned to show more particularly how useless legislation is if not properly carried out, and the question may with some amount of reason be asked, what is the use of a further mining law with reference to blasting, when the present one, if strictly enforced, is quite sufficient to avoid accidents?

If it had been carried out at the Albion colliery, there would certainly not have been an explosion to record with such a fearful death roll.

During the year 1894, the following lives were lost by fatal accidents in the coal mines of the United Kingdom:

1. Explosions of fire-damp and coal dust,	317	= 28.13	per cent.
2. Falls of roof and sides	444	= 39.39	per cent.
3. In Shafts	73	= 6.83	per cent.
4. Miscellaneous underground	177	= 15.71	per cent.
5. Above ground	112	= 9.94	per cent.
	1127	100.00	

But for the Albion disaster, the deaths from explosions would only have been 27 instead of 317, and the total would have been reduced from 1127 to 837.

From falls of roof and sides about 40 per cent. of lives are lost, taken over a long period of years. It is not so much additional legislation that will prevent this class of accidents, as increased care on the part of the officials and workmen themselves, in being careful to set sufficient timber to support the roof stone, as in many cases the accident is traceable to some want of necessary precaution on the part of the officials and workmen.

The ultimate objects of all Parliamentary regulations to control the working of mines in the British Islands are:

a. To ensure to the work people employed the maximum of safety.

b. To protect adult labor by regulating the hours they shall work, and the age at which they shall commence work in or about a mine.

c. To give to the work people, by the appointment of checkweighmen, facilities for ascertaining that they are being paid for the minerals gotten by them.

These objects are all aimed at in the Coal Mines Act, 1887, and the proposed new Mines Bill is intended to amend it, and is to a large extent due to the recommendations of the Royal Commission on Coal Dust, appointed in 1891.

The following is a summary of conclusions arrived at by this Commission:

1. The danger of explosion in a mine in which gas exists, even in very small quantities, is greatly increased by the presence of coal dust.

2. A gas explosion in a fiery mine may be intensified and carried on indefinitely by coal dust raised by the explosion itself.

3. Coal dust alone, without the presence of any gas at all may cause a dangerous explosion if ignited by a blown-out shot or other violent inflammation. To produce such a result, however, the conditions must be exceptional, and are only likely to be produced on rare occasions.

4. Different dusts are inflammable, and consequently dangerous in varying degrees; but it cannot be said with absolute certainty, that any dust is entirely free from risk.

5. There appears to be no probability that a dangerous explosion of coal dust alone, could ever be produced in a mine by a naked light or ordinary flame.

As before stated, the proposed new Mines Bill is based largely upon these conclusions, but having been drafted by men who are neither practical managers of mines nor miners, and as the Inspectors of mines opinions were not consulted in the framing of the bill, it may easily be understood that it requires altering in many important particulars before it can be ready for passing into law.

There have been several meetings between the representatives of owners and miners, with a view to arrive at a bill satisfactory to all, but there are still several points of difference.

The first section of the proposed new bill bristles with difficulties.

It is therein proposed to give to the Inspector power, if he thinks any mine dangerous, as being either fiery, dry or dusty, to serve a notification on the owner, agent or manager to that effect. After the lapse of fourteen days, if this notification is confirmed, such mine shall be subject to the provisions of the Act with respect to fiery or dry and dusty mines.

Under the Act the expression "fiery mine" means a mine or seam or part of a mine or seam, in the return air of which a dangerous percentage of fire-damp prevails.

What is a dangerous percentage of fire-damp in the return air? But this is a question to which in the present state of knowledge on the matter, no definite reply can be given. Under the varying conditions as to the presence of dust etc., the danger from gas also varies, and hence this is a very debatable point.

The expression "dry and dusty mine" means a mine or seam or part of a mine or seam, in which a dangerous amount of coal dust prevails. It is not by any means a decided point as to what may be called a "dangerous amount of dry coal dust," so that there is here further subject matter for dispute.

The power given to the Inspector under this section is not a desirable one, both because it is placing a responsibility on them personally, and more particularly so in those cases where their notifications afterwards form the subject of arbitration, and also because in the majority of districts the number of collieries is so large, that it is not fair play to any man, to place such a duty upon him. There are 3,419 coal mines in the United Kingdom or an average of 285 in each district.

The second section deals with the establishment of "Coal Mines Boards," one to be in each inspectors district, and composed of three persons. One of these, the chairman, shall be a person who is not and has not been, either a mine owner, manager or miner; another shall be a person who is or has been an owner or manager of a mine; and the third shall be a person who is or has been employed in or about a mine, and is not and has not been an owner or manager of a mine.

These District Boards shall be appointed until the end of 1898.

The principal duty of these Boards is that they shall adjudicate as to whether mines on which notifications have been served by the Inspector, if appealed against by the owner or manager, are in the terms of the Act "fiery, or dry and dusty." They will have power to enter and inspect mines or to authorize any person to do the same; to summon any persons as witnesses; to have all books, papers, plans etc., produced that may be considered necessary; and power to administer an oath and require any person to make and sign a declaration of the truth of the statements made by him. The Board may order how and by whom costs in any appeal are to be paid. Sections 3 and 4 also deal with the powers etc., of the District Boards.

Section 5 gives to the Secretary of State power to make special rules for the conduct and guidance of the persons acting in the management of any mine, subject to the provisions of this Act with respect to "fiery or dry and dusty mines," or employed in or about such mines, with respect to any of the following matters:

a. The lights to be used in the mine.

b. The description of explosives to be used, and the mode of storing the same, and the times at which, and the manner in which shots are to be fired; and the number of persons, (if any) to be permitted to remain in the mine whilst shots are being fired.

c. The watering or efficient damping of the mine, or any ways or places therein.

d. Generally the precautions to be adopted for the prevention of accidents from fire-damp and coal dust.

Any special rules made under this section shall be established unless the owner, agent or manager, or the miners or their representative do not within twenty days after the special rules are received by them, object to them in writing. If either side objects as described, the matter shall be referred to arbitration under the principal act.

Section 6 gives power to the workmen at any mine, where a matter is referred to arbitration, to appoint by a majority of two-thirds of their number, a representative to look after their interests on the Board of Appeal.

Section 7 refers to deductions for filling stones or substances other than the mineral contracted to be gotten, and need not be specially referred to here.

Section 8 refers to the appointment of checkweigher by the workmen, and a deputy checkweigher in his absence.

It also states:—"The facilities to be afforded to a checkweigher under Section 18 of the principal Act shall include a shelter from the weather, and a desk or table at which the checkweigher may write, and that the requisite number of cubic feet for two persons be allowed in such shelter, and a sufficient number of weights be provided at the colliery, to test the weighing machine."

It is only reasonable that the requests in this section should be granted, but even this may afford material for the District Board to adjudicate upon, for there may be differences of opinion between some owners and checkweighers as to the number of cubic feet capacity the shelter in the above should afford. The question as to the owners providing a shelter, has already been the subject of many differences in Scotland between the owners and the miners.

Section 9 refers to particulars to be furnished by the owner of a mine on its abandonment, to the Secretary of State.

Section 10 states that a safety lamp should not be used in any mine or part of a mine, unless it is the property of the owner of the mine, and no portion of any safety lamp shall be removed from any mine by any person, whilst the lamp is in ordinary use.

This will prevent men supplying their own lamps, or taking any part of them home, and is a very proper alteration.

Section 10 also states that "only clay or other non-inflammable substance shall be used for tamping."

These are the principal terms of the proposed new Mines Bill, but now that the Liberal Government is out of office, it will no doubt be shelved for a time.

If the Act of 1887 was more thoroughly carried out, such disasters as that at the Albion Colliery would not occur, and therefore there would be little necessity further legislation.

Written for THE COLLIERY ENGINEER AND METAL MINER.

"VENTILATION OF MINES."

Reply to Mr. Sperr, of The Michigan Mining School.

(By J. T. Beard, Ottumwa, Iowa.)

Mr. F. W. Sperr, of the Michigan Mining School, has written a second criticism of "Ventilation of Mines." We might pass over this second criticism, as having been already thoroughly answered in our former reply, but it is our privilege to close this involuntary discussion and we gladly accept Mr. Sperr's invitation.

We realize, moreover, the vital importance which the fair and unbiased determination of this question bears to mining physics and to physics in general; we realized all of this and anticipated the asking of just such questions as Mr. Sperr has raised, when three years ago we began the investigation. We have not been hasty in arriving at any conclusion and are not in any way alarmed but that the book will prove its own substantial defense. At present, the vital point at issue has received the endorsement of the Colliery Engineer and Metal Miner, which we consider the highest authority in American mining. Prof. Munroe, Professor of Mining in the School of Mines Columbia College, in his recent review of the book, takes no exception to the point at issue, but alludes to the book in words of the highest praise, when he says, "The author is qualified by education and experience to speak with authority"; and, futher, after pointing out some points in which he thinks the book could be improved, he adds, "It is perhaps captious and ungrateful to point out the shortcomings in a book which is in many respects one of the best that has yet appeared." The *Colliery Guardian*, London, Eng., in its review of the book, has only words of praise, alluding to its author as being "well fitted for the work he has taken in hand, having a love of his subject and a lucid style." These endorsements are alluded to here in passing, to show that the book has passed muster at some of the higher courts of criticism and established its right to an humble place in our mining literature; and now comes Mr. Sperr and tries to gainsay such right, by claiming that the fundamental principle has been wrongly stated. And, again, Mr. Sperr, by a play upon the common usage and acceptance of terms, endeavors to place the author in the absurd position of condemning his own work.

But, let us at once to the discussion of these vital points. Mr. Sperr asks that we explain the distinction between "*constant*" forces and "*uniformly accelerative*" forces. This we will do and make it so plain as not to be misunderstood. First, we understand *all* force to be the expression of an energy that is either inherent or developed. Second, such force may be either *constant* or *variable*; a force is *constant* when it continues to manifest a uniform intensity during all units of time. We are not concerned with the variable force at the present time. Now, a force may or may not be accelerative in its effect, this last depending upon the existing conditions or environment of the mass acted upon. (1.) The mass may be held intact, when the force acting upon it will manifest itself as a pressure or tension: such as gravity producing weight, or confined steam or gas, producing pressure. (2.) The mass may be impelled by the force against an opposing resistance. (3.) The mass may be free to move under the action of the force and opposed by little or no resistance. These three conditions under which force may act upon any mass are clearly set forth and their measure defined in Chapter II, "Force as Applied to Mine Ventilation." Now, if the force acts to increase the movement or velocity of the mass each unit of time, such force is accelerative in its effect and we term it an *accelerating* force (though this is slightly a misnomer, as the force may be a constant force). If this accelerative effect is uniform for each unit of time, we say the force is *uniformly accelerative*. Gravity acting upon a falling body is an example of a uniformly accelerative force; at the same time, it is a constant force. The steam pressure in the cylinder of an engine represents a constant force, moving at a constant velocity. Let us note the difference between the measures of these two types of constant forces; while the cylinder pressure acts under conditions that yield a constant velocity, the force of gravity acting upon the falling body yields an accelerated velocity:—The measure of the one is evidently Fv (v being the space passed over in a minute of time), (this measure being constant for all time); the measure of the other can only be taken for a differentiated unit of time (g being the space passed over during such unit of time) (this differentiated measure of the force is constant for each successive unit of time). And further, remembering that W or mg represents the force of gravity, and g the acceleration due to such force, Wg or mg^2 becomes the true measure of the force of the falling body, at the end of such unit of time; the work performed during such unit of time being $\frac{Wg}{2}$.

From these practical and familiar examples let us pass directly to the case of the centrifugal force (F) developed in one section of the fan. This centrifugal force is a constant force, as stated upon page 40, being developed from the uniform revolution of the same weight of air. The words to which Mr. Sperr has reference upon page 255 of the June issue should read, "were the velocity a constant velocity, etc.;" they refer to the velocity established by an accelerating force at the end of any unit of time, as not having been constant during that unit of time. Were this velocity a constant, instead of an accelerating velocity, Mr. Sperr's measure of the force, Fv, would be correct; the case would then be analogous to that of the cylinder pressure, or the moving pressure in the airway of a mine (Fv). Mr. Sperr rightly says that the equation (equa. 7, page 40)

$$u = F\frac{f}{2}$$

represents the work stored in a motor in developing a velocity f. And if stored by the fan, we ask, Stored how or where, if not in the established current and given out and responsible for the movement of that current through the airways of the mine? The movement of this air-current is the work of the fan and the work *stored* is the work *given out*, always in the dynamics of fluids. We do not know how there can be any question of this. The method adopted for the development of the fan formula (Chap. VI) approaches a practical differentiation of the work of the fan and its integration through the medium of the established *apv* of the airway. It reveals to us the important fact that the acceleration that a straight-paddle fan imparts to the contained air, in the establishment and maintenance of a current, may be expressed in terms of the velocity of the center of gravity of one section of the fan and the radius of that center of gravity, according to the equation (equa. 5, page 39)

$$f = \frac{v_1^2}{R_1}.$$

Again, in this equation, (equa. 5, page 39), v_1 represents the circumferential velocity of the center of gravity of one section of the fan. In the expression Fv, spoken of by Mr. Sperr, v represents a radial velocity due to the centrifugal force F, acting radially. Mr. Sperr confounds these two velocities when he says: "Since v varies as the $\sqrt{f}$, it varies as n, and Fv varies as n^3." This is not the case, as we said before. If the expression Fv is intended to represent the work of the centrifugal force, v is a radial velocity and varies as n^2, and the total work will then vary as n^4.

The vital point of difference upon which Mr. Sperr bases his whole criticism, in this regard, lies in his claim that "The fan acting with the force F, will start the air from a state of rest and continually accelerate its velocity until the resistances equal the force, when no further acceleration takes place. The velocity, then, is constant, and thereafter the work performed per unit of time is the force, F, multiplied by the space passed over in a unit of time, which space is represented by v." He then regards the force as as no longer accelerative and makes Fv its measure.

We will say in closing that the work of the fan is a continual work of acceleration, by which the inert air from the outside is transformed into an energized current. This work of transformation is continually going on; it is a continuous work of acceleration within the fan. And the measure of this work is as given by equation 7, page 40. Again combining equations 3 and 7, pages 39 and 40, we have

$$u = \tfrac{1}{2}\, mf^2.$$

This last equation agrees with the "fundamental principle," as enunciated by all the standard authorities. We quote from "Ganot's Elements de Physique," a profoundly simple work of upwards of 800 pages, as follows (page 38).

"*When a constant force acts on a mass so as to change its velocity, the work done by the force is equal to half the product of the mass into the change of the square of the velocity.*" The "change of the square of the velocity," for a unit of time, would be the square of the acceleration.

We will only add that Mr. Sperr has not quoted us right, when he says we admit that the tests applied were not "satisfactory and conclusive." We made no such statement, but did say that "The practical results arrived at have demonstrated beyond any reasonable doubt, their efficacy and the correctness of their trend."

We note in our experience that some investigators are easily satisfied with rough and approximate determinations and are prone to explain lack of conformity in their results, as due to this margin of exactness; while another often does himself a comparative injustice by the honesty of his expression. We will let the argument of the book answer the remainder of Mr. Sperr's criticism.

A Convenient Publication.

The Ohio Brass Co. of Mansfield, Ohio, has just issued a catalogue of electric railway supplies, which is called "Catalogue No. 3." It is a very complete and convenient publication which should be in the hands of every manager of a mine in which electric machinery of any kind is used. It is sent free on application.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

Cleaning and Concentrating Outcrop Iron Ores.—An article on this subject, by Walter J. May, has appeared in the *Colliery Guardian* and the reader cannot fail on due consideration to appreciate the importance of the matter from a mining point of view, for it is a fact, that an ore of poor yield is worth more near at hand, than a rich ore far off; and an outcrop ore of poor yield, may when assorted and dressed yield the highest percentage of metal of the finest quality. The object of the writer is to show how the value of outcrop ores can be increased and here are his plans.

Outcrop ores, however abundant, usually contain too low a metallic content to be worth working, while siliceous matters are often very high indeed, but where on examination these materials are found to be easily separable, and where sulphur and phosphorus are practically absent from the clean ore, it is worth while to consider such ores with a view to working them on a commercial scale. It is true that the value of the crude ore is a small one, but against the small value we have to set the small cost of working, which as opposed to underground working is a mere nothing, always providing that systematic and economical methods be adopted. In fact, as opposed to the underground working of low grade ores, the cost of working surface ore may be taken as from a fourth to a sixth of that underground, especially where there is little cover to be removed. Indeed, if one excludes the cost of uncovering, surface ore should be loaded into trams for less than 12c. per ton, the value for dressing ranging from 48c. to $1.08 per ton according to the amount of recoverable ore. Of course this refers to hematite ores, but others would have a considerable value in many cases, particularly where the means of transit are favorable, as often deposits occur which can be forwarded to the furnaces for a low rate if they could be made sufficiently high in metallic value. It must always be borne in mind that no matter what may be the metallic value of an ore, the cost of carriage is precisely the same, it costing just as much to convey a ton of 35 per cent. ore a certain distance as it does to convey one having a 60 per cent. metallic content, while the financial values are widely different. In fact, a 60 per cent. hematite in a clean state would find a ready sale, while the cost, if produced from some outcrops which the writer has inspected, would return a handsome margin of profit.

In conclusion, it is well to note that there is scarcely a low grade ore in this country but can be concentrated up to a high point of metallic content, and that profitably, if a sufficiently large supply of crude ore is provided and efficient plant is laid down, but in every case the plant must be suitable for the treatment of the particular ore in hand.

A Competive trial of Flue-heated Coke Ovens.—In Westphalia, Germany two of the most noted systems of flue-heated coke ovens have been put to a practical test, not only for by-products, percentage of coke, and speed of coking, but for the quality of the coke in actual use in smelting iron.

For the test a battery of 30 ovens was selected at each of two stations, and coals were brought from the same mine, and of first rate coking quality so that no doubt concerning the results could arise in reference to the coal used. The first battery consisted of 30 Otto-Hoffmann ovens with vertical heating flues and air-regenerators. These ovens are in use at Germania mine, the property of the Gelsenkirchen Mining Company at Marten, Westphalia. The second battery also consisted of 30 ovens belonging to the Carves-Hussener system and in use at the works of the Coal-distilling Company at Bulmke.

The trials commenced at 6 A. M. on the 7th, and finished at the same hour on August 18th, 1893. Total time 11 days or 264 hours. The time of coking each oven was limited to 48 hours. The trials were conducted under the inspection of controllers appointed by the competing companies.

The results are as follows: Highest temperatures of ovens, Carves-Hussener 1320° *C*; Otto-Hoffmann 1100° *C*. The following table is a test of coal and coke. *C-H* represents Carves-Hussener ovens. *O-H* represents Otto-Hoffmann ovens.

	O-H	*C-H*
Coal charged, tons	954.91	932.53
Water in coal, per cent	10.31	12.06
Coke drawn, tons	731.64	660.98
Water in coke drawn, tons	46.73	4.13
Total coke, (dry) tons	684.91	656.85
Percentage of yield, (dry)	80.65	81.10
Blast furnace coke, (dry) tons	609.89	616.21
Soft burnt	77.03	40.65
Water in blast furnace coke, per cent	6.35	.61
Water in soft burnt coke, per cent	6.49	.57
Percentage of blast furnace coke, (dry)	71.61	75.14
Percentage of soft coke, (dry)	9.04	4.96

31.67 tons less coal were charged into *C-H* ovens than went into the *O-H* ovens.

The chemical and physical properties of the two

	O-H.	*C-H.*
Ash, per cent	8.90	9.20
Total sulphur	1.40	1.50
Specific gravity of solid coke	1.87	1.87
Porosity	52.20	56.00
Volume (solid) per 100 grammes	52.00	53.00
Moisture, per cent. at furnace	2.51	5.14

classes of coke were determined by Dr. Thomer of Osnabruk, and were as shown above.

The manager at the smelting works considered the Carves-Hussener coke was the best.

A Creep in a French Coal Mine.—A translation of an article in the *Annales des Mines* by M. E. Coste lately appeared in the *Colliery Guardian*, and M. Coste seems to think that what occured in Montrambert colliery was unusual, whereas in fact the movements referred to, have been common experiences wherever deep mining has been practiced. The title of the article is "Alteration of Coal due to Subsidence," and as the description is well done, and cannot fail to give our readers that have never seen a creep a graphic idea of one, we give M. Coste's article with a qualifying remark, that where the "slack" or dust coal is gobbed, the outrush of air and gas from the goaf when the roof and the floor close, carries with it a stream of fine particles of coal, and hence the deposit referred to. The "earthquake" and the "noises" are well known, and require no further notice.

"In May last a sudden disruption of strata amounting to a small earthquake, occurred at the Montrambert colliery, Loire, France, producing an unusual crushing effect upon the coal. The working area is about 2,200 feet long, and the seam is 5 feet thick at one end of the lease, and thins down to 3 feet 6 inches at the other. Overlying the coal is a roof of coal-shale averaging 20 inches in thickness and above that a strong sandstone, while the floor consists of a highly siliceous fire-clay. The stalls had been carefully packed, but the roads leading to them were not fully gobbed. Loud detonations have been sometimes heard, tolerably rare as the lower portion of each panel is being worked, but becoming more frequent as the working advances. In 1888 a sudden displacement occurred to either the roof or floor of the seam, causing a shock that was felt for a considerable distance.

"The noises recently heard were attributed to the fracture of the floor, and they often corresponded with shocks sufficient to throw down the props. On May 5 1895 a very severe shock occurred, cracking the timbers and accompanied with a violent rush of air. Fortunately nearly all the miners were out of the workings at the time, but most of the lights of the few men in the roads were blown out, and the men tossed about. The inspection showed that the roof and floor were nearer together than before, the shale of the roof had fallen in, and in places the roads were blocked, and the stalls nearly filled. In the disturbed area all the cleavage planes of the coal were opened, and the coal was so tender that a mere touch brought it down, and a thick cloud of dust was formed, which had not been the case before. A small bed of very fine coal dust was found next the floor, that was not there before the occurence. Everywhere the coal was found to be in a crushed state and very friable, and the commotion was felt at the surface."

Modes of Working Coal.—A paper on the above by Mr. J. B. Hanford of West Monterey, was recently read before a meeting of the Mining Institute of Western Central Pennsylvania, and was as follows:

It must be obvious, that a thick seam of coal will yield more than a thin one, and that the greater the yield per acre the smaller must be the costs per ton for making and keeping the entries, etc. These premises being granted, it follows, that a thin seam cannot be worked so cheaply as a thick one, and therefore, to make the working of a thin seam a profitable transaction, the very best methods must be adopted in the extraction of the coal. As the double-entry system can be worked cheaper than the single entry, I conclude from observation, that if double-entry is the cheapest system of working a thick seam, there is nothing to prevent it from displacing the single-entry system in a thin seam, and thus as far as the advantages of a good system of working are concerned, the thin seam would secure as good results as the thick one. It is true the cost of making double entries is considerable at first, but this extra cost is a good investment, because it is at all times a difficult matter to properly ventilate a thin seam and especially where single-entry is the mode of working, because the great number of doors required is a prime source of waste of air current; and again it is clear that the increased sectional area of the double entries secures an increased ventilation, free from the waste produced by doors. Now as the law provides for an "Ample ventilation." Article IV, Section 1, Act of Bituminous Coal Mines of Pennsylvania, and again Article II, Section 3 provides for two entries or other passage ways, inferentially and on the face of this, it is clear we cannot adopt the single-entry system. To show the aim of my contention, however, let us assume that we have a lease of 300 acres, the seam being 3 feet thick with 6 inches of draw slate, and resting on a soft fire-clay floor, the cover or overlying strata being 300 feet thick. Further let us assume that the mine is operated by a drift of 3000 feet along the butt line, and that rooms are turned off every 36 feet and that the mine is ventilated with a furnace which provides 200 cubic feet for every man, and 700 cubic feet for every mule, and let us see what will be the aproximate cost of extracting the mineral by each of the systems of working that now are before our attention.

Leaving out the constantly recurring expense of maintaining the doors and roads, we have roughly the following cost in in each case.

Driving one entry 3000 ft. at $1.75 per yard	$1750.00
Driving airway 3000 ft. at 75c. per yard	750.00
Lumber for doors and roads	123.00
Labor for erecting doors, etc	106.60
Ties and railing for track	600.00
Hauling coal	7248.00
Allowing 10 per cent for loss due to single track	724.80
Coal for ventilation	1445.40
Total Cost	$12747.80

If the rooms are driven 75 yards long the main entry will give a tonage per annum of 181,239 tons or the cost of the roads on one year's haulage is 7 cents.

Taking the dimensions of the drift as already given, but the entries as now 40 yards apart.

Two entries	$3500.00
Ties and railing	1200.00
Hauling coal	9272.00
Breakthroughs at 75c. per yard	300.00
Coal for ventilation	730.17
Total Cost	$15002.17

Total tons of coals per annum by double-entry 231,801 tons. Costs per ton 6.4 cents or a total saving of $5500 for the double entry system.

By leaving a large chain pillar, the coal will not be so much crushed, thus securing a larger per centage of lump coal.

Blown-out Shots.—An article on the above subject by James Ashworth, M. E., has appeared in a recent issue of the *Colliery Guardian*.

Mr. Ashworth's article aims at showing that the blasting powder at present in use, is an inferior and cheap preparation in which an excess of nitre is used in its composition, hence the dangers attending its use, for it is now an established fact, that, in the absence of fire-damp, if the carbonic oxide and flame from a blown-out shot is projected into air holding in suspension only a little coal dust, an explosion ensues which is the nucleus of a greater one, for if the first explosion raises a cloud of inflammable dust, the second one fills the mine with flame.

Mr. Ashworth further shows that nothing has yet been done to compound the three ingredients in gunpowder in such proportions as will insure complete combustion, as is nearly done, in the burning of *sporting* powder. He chaffs at the old, old story "75 per cent. nitre, 15 per cent. charcoal, and 10 per cent. sulphur," as the true, and best proportions for good service, and he shows, that it has been demonstrated that a better blasting powder and cheaper, and perfectly safe, can be made by increasing the proportion of charcoal, and correspondingly reducing the per centage of nitre. No doubt there are reasons for the unwise continuance of the old proportions in blasting powder, and three of them are as follows:

First.—Nitrate of soda is very cheap.

Second.—You wish to buy in the cheapest market.

Third.—Manufacturers compete in price.

It will be seen, however, that 8 ounces of gunpowder having its ingredients properly proportioned for complete combustion exerts the same blasting force as 24 ounces of the imperfect and dangerous blasting powder in common use. The following is the most important portion of Mr. Ashworth's article.

That it is possible to manufacture a blasting powder which for all ordinary mines is quite safe to use, has been proved years ago by one firm of high standing, who introduced a powder called "extra strong mining" (E.S.M.), fired preferably by a detonator. This powder was of much the same composition as the best artillery powder, but it differed from it in its physical qualities—it was unglazed, it was soft, the charcoal was not common charcoal, and it was incorporated for a long time in the mill, and not merely rubbed together. Being unglazed a charge was readily ignited, and the combustion, by reason of the excellence of the ingredients and thorough incorporation and being fired by a detonator, was such that a charge of 8 oz. was fully equal to 1½ lbs. of ordinary powder.

This increase of force was not entirely due to the excellence of the ingredients, but also to the detonator, which had the effect of firing the whole charge instantaneously and not, as with a common fuse, allowing the ignition flame to pass from end to end of the charge at a comparatively slow speed.

These statements of practical experience with a high-class powder prove that the risk of accidents from blown-out shots may be reduced to a minimum if a proper and suitable article is demanded and its use enforced. It is, however, possible to show by the result of an actual experiment what change takes place in the resultant gases from a shot of high-class powder, by referring to the experiments made by Karolyi. He fired a charge of powder, composed of saltpetre 73.78, sulphur 12.80, carbon 13.39, in a very strong iron mortar and then tested the resultant gases, and he found that 1 lb. of powder produced only 10.1 litres of carbonic oxide and 42.3 litres of carbonic acid gas, and 37.3 litres of nitrogen, but he found also 2.6 litres of marsh gas, and 5.9 of hydrogen.

Both the latter resultant gases doubtless originated from the charcoal, and therefore if these gases can be reduced by the use of a more suitable charcoal, there is no doubt that we shall be able to blast with increased safety in non-dangerous mines if proper regulations are enforced by Act of Parliament, and the gunpowder-makers are made amenable for turning out a bad article.

The enforcement of blasting by electrical or other detonator would undoubtedly afford an extra point of safety as ensuring the ignition of the whole charge more quickly than by ordinary fuse, as if bobbins of powder are used and the fuse is turned up and fixed in the first cartridge and the rest of the bobbins threaded on above, the consequence is that the charge is ignited at the back, and if the hole is "fast" the front part of the charge is blown out when only partly consumed, and cannot fail to add to the extent of the flame and of the intense combustion which results when the carbonic oxide is burnt into carbonic acid.

If dust of any sort is present, the extent of the flame must be increased (*vide* Sir F. Abel's experiments in connection with the Seaham disaster), and if, as seems possible, there is any firedamp lurking about, as suggested at Malago Vale, it would be sucked out by the force of the blow-out and consumed at the same time that the carbonic oxide is burnt into carbonic acid.

In conclusion, if high-class gunpowders are alone used we may possibly still have blown-out shots, but there will be every difference in the world in the result, because the combustion will be already complete, and the flame will be limited to that which comes out of the hole, and not intensified by a second and more intense inflammation from the burning of the carbonic oxide, which is the principal resultant gas from a common miners' blasting powder.

Water Tube Boilers.—The water tube boiler is at present the general favorite, as it secures the greatest economy and efficiency in the raising of high pressure steam. Before, however, proceeding to give the details set forth in a very important paper lying before us, it may not be out of place to notice definitely the meanings of some of the terms employed. The *water* tube boiler is in contradistinction to the *fire* tube boiler. In the *fire* tube, such as the tubes of the Lancashire and Cornish boilers, and the multi-tubes of the locomotive and marine boilers, the flaming gases pass through the tubes, while the water within the boiler covers the exterior surfaces of the tubes. In the other, or contra-case, the water is within the tubes, and the flame acts on the exterior surfaces of the tubes, hence they are called "water tube boilers."

The Advantages of High-pressed Steam.—It requires nearly as much heat to generate steam at the pressure of the atmosphere, as it does to generate it at 200 pounds pressure on the square inch. Although in the latter case the temperature of the steam would be considerably above 212° F, yet as the sensible heat of the high pressed steam *increases* the latent heat *decreases*, and the result is, it requires very little more heat to produce a pound of steam at a pressure of 200 pounds on the square inch, than that required to make a pound of steam at a pressure of 15 pounds on the square inch.

We see then how it is that high pressed steam secures such economy, and in this we also see how it is that all steam users desire it; but there are important factors required in the *modus operandi*, and these are a *high* temperature, and a large heating surface for the boilers. The reason why these factors are required is found in the fact that for steam to be formed, the temperature of the burning gases of the fire must be somewhat above the temperature of the steam, to supply *latent* heat, and as the rapidity with which steam is produced is in proportion to the number of degrees the heat is *above* the temperature of the steam produced, we see at once why a high temperature is required and to still further impress the judgment let us notice and not forget, that:

The energy of vaprofication is directly proportionate to the units of heat absorbed per minute by the heating surface of a boiler. Now the absorption per minute of a square foot of heating surface is reckoned to be good in a multitubular boiler when it is equal to 8 units of heat, but to generate very high pressed steam we require an absorption per square foot per minute of not less than 12 units of heat, therefore the subject is one claiming universal attention, and Mr. Allen Stirling of Chicago, recently read a paper before a meeting of the Mining Institute of Scotland, on the subject, headed, "Water Tube Boilers." The principal points touched on by the paper are as follows:

"The Stirling boiler is practically self-cleaning, because the water is fed into the back upper-drum, and descends with a slow motion of 6 inches per minute to the mud drum through the back group of tubes, which have an area 100 times greater than that of the feed pipe.

"On entering the mud-drum the feed water has reached the boiling point corresponding to the pressure under which the boiler is working.

"The scale-forming matter, together with other solid matter held in suspension prior to the feed water entering the boiler, is deposited on the bottom of the mud-drum from which it is readily blown off. This arrangement ensures the supply of practically pure water to the front and middle groups of tubes, where the steam is made. The Stirling boilers are giving the highest results, and are only opened once in six months, and even then very little cleaning is necessary.

"The advantages of using high pressure steam are widely recognized, and its use in modern engines is increasing rapidly. The merits of the water tube as compared with other boilers for carrying high pressures, are conceded by the best engineering authorities and the Stirling water-tube boiler commends itself because, (1) there are no riveted joints exposed to the heat; (2) there are no flat surfaces, and consequently, no stays are required; (3) the outside surfaces of the tubes are the only parts with which flame comes in contact; (4) the ends of the tubes are in water; (5) there is no heating surface above the water line; (6) all the parts are of wrought steel; (7) the tube plates are made thicker to allow for drilling the tube-holes; (8) expansion and contraction have been thoroughly provided for; (9) the water is divided into small sections; (10) the circulation is steady and thorough; (11) it is practically self-cleaning, so that the boiler seldom requires to be opened; and (12) there are only four joints to break to get access to every part of the boiler."

The following are other advantages claimed by the author of the paper for this water-tube boiler.

"The Stirling water-tube boiler occupies less space than any other. The small space required for boilers and fire-room effects a saving in cost of ground."

The following are the principal dimensions of Sterling boilers recently erected in Scotland:

	Localities.		
	Kilmarnock.	Glasgow.	Motherwell.
Heating surface, square feet	621	2387	4370
Grate surface, square feet	11	34	90
Ratio of heating to grate surface	56	70	48
Number of water tubes	78	264	392
Diameters of water tubes in inches	3¾	3¼	3¼
Diameters of drums in feet	3	4	4
Lengths of drums in feet	5	9	11

A Lecture on Mining.—An important lecture was lately delivered by Mr. W. N. Atkinson, H. M. Inspector of Mines, before a meeting in London of the Federated Institute of Mining Engineers. This lecture is a reflex of the experience and aspirations of the Mining Engineers of Great Britain, and, therefore, claims special notice. The subject is treated under eight heads, as follows:

Safety in Mining.
Falls of Roof and Sides.
Explosion of Fire-damp and Coal-dust.
Accidents in Shafts.
Underground Accidents.
Surface Accidents.
Training of Mining Engineers.
Distribution of Power by Electricity.

Safety in Mining.—Mr. Atkinson proves with the following facts that safety in the practice of mining is progressively increasing. We may congratulate ourselves that, relatively, the miner's occupation is now much safer than it was during the earlier part of the period for which statistics are available. Thus, according to the official statistics relating to mines under the various Coal Mines Regulation Acts (which are the statistics always referred to) the ratio of persons employed in and about our coal mines to each death during the five years 1851–55 was 233 (death rate per 1,000 = 4.294), whilst in the five years 1890–94 the corresponding ratio was 624 (death rate per 1,000 = 1.602), so that during the latter quinquennium more than two and a-half times as many persons were employed per life lost as in the earlier period.

Explosions of Fire damp and Coal-dust.—The lecturer shows that during the last 44 years the loss of life from explosions has been greatly reduced. "Explosions of fire-damp and coal-dust account for 21 per cent. of all the deaths from accidents in and about the mines under the various Coal Mines Regulation Acts during the forty-four years, 1851–94. The annual loss of life from explosions varies more widely than that from any other class of accidents in mines. During the past forty-four years it has varied from 651 in 1866 to 49 in 1888, the average annual number of deaths from this cause being 220. For several years past explosions in coal mines have been the subject of much controversy and special investigation, owing to the advancement of the opinion that coal-dust is the chief source of danger in extensive explosions. This contention is now widely admitted, although there are still differences of opinion concerning the relative influence of fire-damp and coal-dust in mine explosions, and as to the conditions under which coal-dust may cause or extend explosions."

It is next shown that the occurrence of explosions has diminished since the dangerous character of coal-dust became known, and he says:

"On the other hand, we must remember that the average depth of coal mines is increasing, and this depth is accompanied by increased dryness, so that in the future a greater proportion of mines will be subject to danger from coal-dust than in the past. Statistics indicate that since the time when the influence of coal-dust in colliery explosions was seriously considered, there has been a great reduction in the loss of life from this cause."

He next treats on the subject of safety lamps by saying: "Improved safety lamps have now been universally adopted, but in this respect there is room for further progress. For some time we have appeared to be on the eve of obtaining a satisfactory electric mining lamp, but as yet it is not forthcoming. With respect to the lamps in use two points strike me as specially requiring attention. The first is the abolition of the old screw-lock and the adoption of a lock incapable of being opened surreptitiously without detection, and this is an improvement of easy attainment at small cost, applicable to most of the lamps now in use. The other point is the risk attending the use of lamps with close shields, that lamps may be taken into the mine without the gauze. That this is a real risk is proved by its occurrence in the experience of a number of persons. The remedy is not so obvious as the improved lock, and it involves some alteration in the construction of the lamps, but it is a danger deserving of serious attention. The introduction of improved gas-detecting lamps, capable of indicating the presence of very small proportions of inflammable gas, enables a more accurate estimate to be formed of the production and presence of fire-damp in mines. For some time I have used Dr. Clowes' hydrogen lamp for this purpose with much satisfaction.

Falls of Roof and Sides.—"Falls of roof and sides in mines have always been, and probably always will be, accountable for more accidents and deaths than are due to any other single cause. The reason is not far to seek. It is a danger common to all mines, and one to which every person engaged underground is to some extent continually exposed. About 40½ per cent. of all the deaths from accidents in mines under the Coal Mines Regulation Acts since 1851 were caused by falls of roof and sides. The statistics show, nevertheless, that there has been a steady decline in the death rate from falls. The methods of preventing accidents from falls are well known to all engaged in mining, and there is no prospect of the discovery of any new principle for the avoidance of these accidents. The only hope of improvement lies in the better application of the old methods. The substitution of iron or steel supports for timber is likely to extend for economical reasons, and may to some extent add to safety."

Accidents in Shafts.—Mr. Atkinson further makes the following wise remarks. Shaft accidents account for 13¾ per cent. of the deaths recorded since 1851. The statistics show a more marked decrease in the number of deaths by shaft accidents than from any other single cause. Although it cannot be shown by the figures it is probable that the decrease is due in a greater degree to lessened loss of life amongst persons simply using the shafts to pass to and from their work, than to increased safety to those engaged in sinking and repairing shafts and other work connected with shafts. As in the working of railways, it is the mere passenger who runs the least risk. The reduced number of shaft accidents is no doubt due to the great improvements which have been effected in the fittings of shafts, the almost universal use of guided cages, automatic fences and other improved appliances connected with the shafts and winding engines. In many cases a very high degree of perfection has been attained in this respect. Points to which attention should be directed in order to prevent loss of life in shafts are the maintenance of the sides of the shafts and the shaft fittings in thoroughly good repair; also the avoidance as far as possible of the use of hangings-on or hooking places in mid-shaft, and where that is unavoidable the adoption of special appliances for securing safety at such places. Then the use of good ropes of adequate strength vigilantly examined, oiled and cared for; periodical recapping, and, where there is the probability of internal corrosion, extra precaution with regard to the length of time during which the rope is used, as ropes outwardly perfectly sound, may break suddenly from this cause. The use of detaching hooks may now be recommended with confidence, and they should be supplemented by the provision of keps or catches to arrest the fall of the cage in case the chains are broken, as may occur by the fall of a cage carried up by its momentum after the rope is detached. Appliances for arresting the fall of the cage in case of the rope breaking have not arrived at such perfection as to warrant the recommendation of their general use.

Underground Accidents.—Accidents under this heading caused 17½ per cent. of the deaths recorded since 1851, and the death rate shows a tendency to increase rather than the contrary. They are usually single fatalities caused by the use of explosives, suffocation by gases, accidents in connections with the haulage of minerals and arising from sundry other miscellaneous causes; but occasionally a large loss of life occurs from fires underground and by sudden irruptions of water, both of which are included with miscellaneous underground accidents. A large proportion of these accidents occur in connection with the movement of tubs, and in many cases both safety and economy would be increased by the adoption of improved underground rolling stock and more perfect haulage roads. I will only refer further to accidents arising from fires and irruptions of water. Underground fires are of two classes—those due to spontaneous combustion, called gob-fires, and others caused by accidental ignitions. Fires of either class may result in loss of life either by suffocation by the products of combustion or by explosions caused by the fires. In seams free from firedamp gob-fires do not usually have fatal results, but in fiery and dusty seams they are a source of great danger on account of the risk of explosions. The causes of spontaneous combustion in mines are not clearly understood, and the liability of any seam to its occurrence is only discovered by experience.

During recent years there have been several very serious accidents from fires underground caused by accidental ignitions, most of which were due to the use of naked lights in dry workings, and especially by "torch" or "comet" lamps.

The work of surveying mines and making the plans has in the past often been confided to incompetent hands, and even now the importance of the subject is frequently underrated. It would not appear to be unreasonable to insist that persons entrusted with the making of mining plans should be required by law to hold some recognized proof of their capacity.

Surface Accidents.—Accidents on the surface in connection with mines amount to 7½ per cent. of all the accidents recorded since 1851, and for the last twenty years at least the statistics show no improvement, the average death rate being slightly under 1 per 1,000 of the persons employed above ground. These accidents are not of a character peculiar to mining, but are similar to those occurring at other works where machinery and boilers are used, and where railway wagons are moved in confined places. The number of accidents in connection with the movement of wagons about the screens might be reduced by the provision of greater clearance between the wagons and the structures near which they are moved.

Training of Mining Engineers.—This is an age of education and with the introduction of electrical, and the many other examples of scientific engineering, the British realise the importance of technical education as follows:

"In view of the continual development of the mining industry, and the increased difficulties and dangers to be overcome as mines become deeper and more extensive, and the introduction of complicated and costly machinery of various kinds, it is more than ever requisite that, to be successful, the mining engineer should have a very efficient training in both the practical and scientific knowledge of his profession. There is no reason why a thoroughly practical knowledge of mining should not be accompanied by considerable scientific attainments, and the mining engineer will find it advantageous to have some acquaintance with nearly all the exact and physical sciences."

Distribution of Power by Electricity.—Mr. Atkinson seems to be in touch with the idea so many entertain, concerning the transmission of the energy in fuel. Some have proposed for years, that the combustible elements in coal should be converted into gas and transmitted through pipes to the points where heat, light, and energy were required. But he proposes a cheaper mode of transit, by despatching the energy in a spiritual form as electricity through cables, where it could be used at all points as heat, light, and a mechanical agent.

A subject of interest to colliery-owners and mining engineers which appears to be looming in the not very distant future, is the establishment of large central installations situated in coalfields, for the distribution of power to distant places by electricity. If this is found practicable there will be an immense saving in the cost of carriage of coal to the consumer, and a mitigation of the smoke-plague afflicting so many manufacturing towns. In some cases it might even be to the advantage of colliery owners to initiate the system for the distribution of energy to groups of mines. A much more speculative question refers to the possibility of utilizing the interior heat of the earth by means of deep shafts and boreholes. A few weeks ago I read of a scheme for attempting to solve the question by a series of shafts and borings in connection with the Paris Exhibition of 1900. If this source of heat and power ever became available on a large scale it might materially reduce the demand for both miners and mining engineers; hence there is solace in the reflection that many things are likely to happen before we get deep enough to be able utilize the heat of the nether regions.

Written for THE COLLIERY ENGINEER AND METAL MINER.

A NOVEL STEEL TIPPLE.

Description of the Tipple at Forest Hill Mine, Near Douglass Station, Pa.

The steel tipple at the Forest Hill mine, owned by Messrs. Ellsworth, Morris & Co. of Cleveland, Ohio, and located near Douglass Station on the Pittsburg, McKeesport and Youghiogheny R. R., possesses some novel features. It was built to replace a wooden tipple, which was destroyed by fire. The original tipple was about 30 ft. high from the rail to the tipple platform, and was connected with the pit mouth by a double track incline. The distance between the tipple and pit mouth was short and the incline was very steep. There was room for but two cars on either track between the foot of the incline and the tipple dump. This, of necessity, limited the trips on the incline to two cars, and consequently limited the capacity of the tipple. In designing the new tipple it was decided to do away with the incline and increase the height of the tipple house bents to about sixty feet, so that the mine cars could be run directly to the dump from the pit mouth. There are two loaded tracks on the tipple, each holding ten cars between the cross over and the switch at the pit mouth. These tracks have a descending grade to the dump of 1½%. The dump is the Phillips Automatic Cross Over Dump, (manufactured by the Phillips Mine Supply Co. of Pittsburgh, Pa.), and the cars after dumping, run automatically to the switch back and back to the foot of an incline, up which they are taken by a sprocket chain to the head of the incline. At this point they are automatically released from the sprocket and run by gravity down the empty track into the main entry of the mine, where the empty trips are made up. The sprocket on the incline is run by a ten horse power engine situated on the lower floor of the tipple.

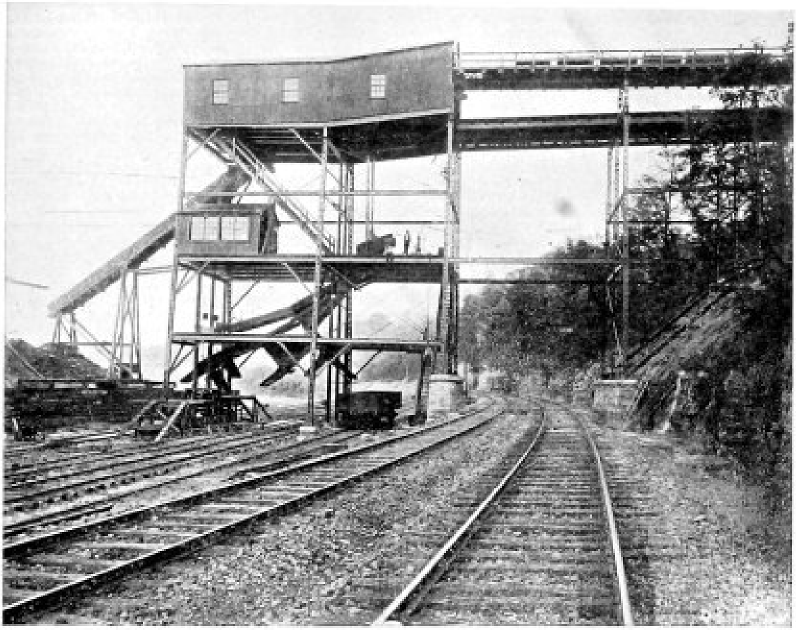
The coal, instead of being dumped directly into the screens, which is the case in tipples as usually built, goes into a counter-weighted drop basket, which is lowered, by the weight of the coal, about thirty feet, to the screens below. The gate at the lower end of the basket is opened by check chains just before it reaches the lump screen and the coal slides out of the basket over the screen. The descent of this drop basket is controlled by friction brakes on the drum, and to prevent too great a shock at the bottom, the basket is checked by spiral springs on the end of the chains. The guides on which the basket runs are six by eight inch yellow pine, and on the basket there are four friction rollers on each side, working on the sides of the guides. The time of lowering the basket, dumping the coal on the screens, and raising again for the next load is less than one-half minute.

By increasing the distance between the two outer tracks to 17 feet, from center to center, and the addition of the second fly to the lump coal chute, it is possible to load box cars with lump or run of mine coal on either of the two outside tracks, instead of the outer track only, as is generally done. This saves considerable time and increases the capacity of the tipple when loading box cars, as while trimming the coal in the outer car, coal may be run into the car on the inner track, and *vice versa*. The introduction of the nut and slack bins is also a source of time saving, as they allow lump coal to be loaded while shifting a car already loaded with nut or slack, and dropping empty cars into place on the nut and slack tracks.

The coal is all weighed on the track scales, the weigh office being on the first floor of the tipple, and the scales are connected by rods running from the track level to the beams in the weigh office.

The miners' checks are taken from the mine cars at the dump and dropped into a tin tube leading to the weighing office on the floor below. The brakes on the drop basket drums can be operated from either floor.

The tipple is at present equipped with a single set of screens, and its capacity is twelve hundred tons of lump coal in ten hours, but the structure is so designed that a second set of screens may be added in the future, should the output of the mine demand it. Messrs. Wilkins and Davison of Pittsburgh, Pa., were the designing engineers, the structural work being built and erected by the Schultz Bridge and Iron Company of Pittsburg, the screen equipment by the Phillips Mine Supply Company, and the incline sprocket by Messrs. Heyl and Patterson of Pittsburg.



STEEL TIPPLE AT FOREST HILL MINE.

Jeffrey Conveying Machinery for Coal Vessels.

The accompanying illustration represents a coal conveyor, installed by the Jeffrey Manufacturing Company, of Columbus, Ohio, for the Mobile Coal Company, Mobile, Ala., on their wharf, for the purpose of coaling steamers. It receives the coal from bottom dump cars on the trestle conveying same to a height of about forty-five feet into a storage pocket from which it is delivered into vessels by means of chutes at a rate of about 250 tons per hour.

This conveyor is about 175 ft. in length, is constructed of double steel chain of great strength and durability, to which iron scrapers are fastened by means of special swivel attachments. The coal is carried by the scrapers referred to through a steel trough, so constructed as to present a smooth and continuous surface, offering no impediment to the passage of the coal. The chain operates in iron guides, away from the material, supporting the scrapers clear of the trough bottom, thus greatly reducing the friction and wear, without being attended with that unbearable screeching noise, produced by ordinary conveyors where the scrapers slide on the bottom of trough. The operation of this conveyor is perfect, carrying 120 tons run of mine coal continuously, with the least amount of breakage and minimum amount of power. All of the working parts are simple, strong and durable, and easy of access in case of repairs.

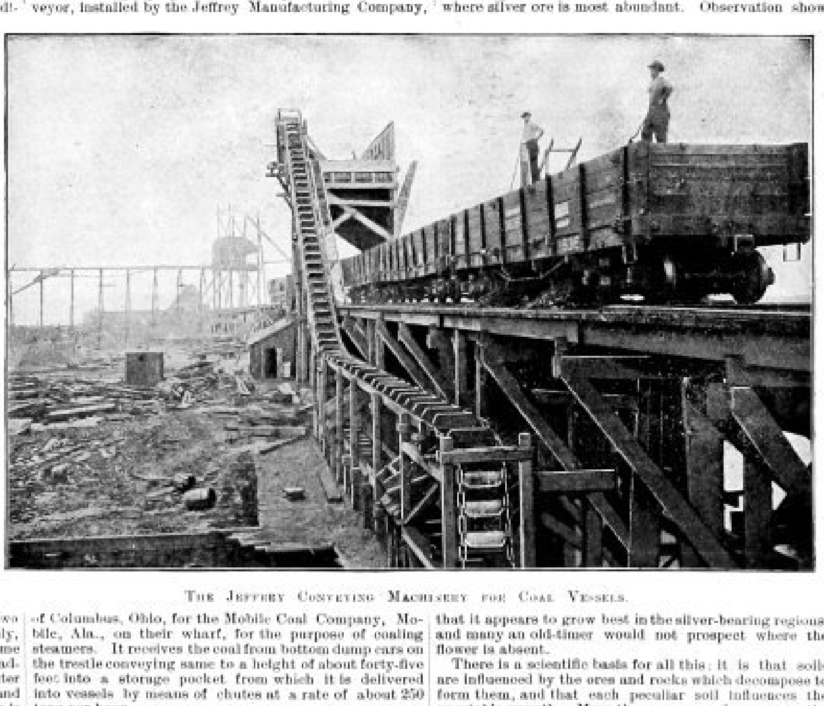
The conveyor is driven from the delivery end by an engine located on the ground, the connection, (owing to the distance), being made by wire cable operating over rubber filled sheaves.

In connection with this The Jeffrey Company also furnished a car puller, which is not shown in the illustration. This car puller consists of a friction drum, driven by the same engine that operates the conveyor, by means of which the empty cars are pulled away and the loaded cars into position for unloading.

The results obtained by the use of this machinery could not be accomplished nearly so rapidly and economically by any other known method. The saving in labor is very great, to say nothing about the safe handling of the coal and the very short time vessels are obliged to wait for their supply of fuel.

The installation of machinery, as represented in the illustration, is only a small part of the Jeffrey Manufacturing Company's extensive business. This company equips coal mines complete with coal cutters and drills for mining the coal, electric locomotives for hauling it, elevators, conveyors and screens for preparing and loading it into cars ready for shipment. It also furnishes appliances for the mechanical handling of material in straw board, pulp and paper mills, canning factories, saw and lumber mills, tanneries, smelting and refining works and numerous other industries. All who are interested in this class of machinery and desire to obtain the latest and most approved appliances are invited to write for full particulars and prices.

A large and handsomely illustrated catalogue will be mailed to any part of the world upon application.



THE JEFFREY CONVEYING MACHINERY FOR COAL VESSELS.

Plants and Minerals.

The man who thinks a knowledge of botany cannot aid a prospector does not know much about the science. The truth is that the mineral characteristics of a soil influence very greatly the plant growth in the soil. They change the shade and color of leaves and grass and blossoms, as well as often dictate what plants shall and shall not grow there. There are plants which grow only where there is considerable zinc in the soil, and others which apparently grow best, or only, where there is lead in the earth. In the lead regions of Illinois and Wisconsin the old-time prospectors looked as much for the vegetable growth as an indication of ore as they did for float. Old-time Colorado prospectors remember the little "silver flower" found so abundantly in the mountains in parts of Clear Creek and Boulder Counties, where silver ore is most abundant. Observation shows that it appears to grow best in the silver-bearing regions, and many an old-timer would not prospect where the flower is absent.

There is a scientific basis for all this; it is that soils are influenced by the ores and rocks which decompose to form them, and that each peculiar soil influences the vegetable growth. More than once we have seen the course of a lode clearly marked by the vegetable growth along its entire length. The old prospector sees sermons in grass and trees as well as stones.—*Mining Industry and Tradesman.*

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

Velocities on Inclines.—Laws of Resistance on Inclines.—Times and Velocities on Inclines.

58. **Velocites on Inclines.**—Figure 102 is introduced to still farther explain how the gradient of an incline may be found when the length and time for the incline are given, and how to find the time when the gradient is given.

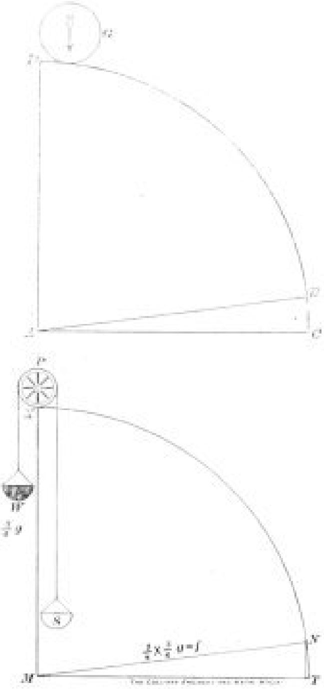


Fig. 102.

In the upper example in the figure, $A\ D$, $A\ B$, and $A\ C$ are radii of the same circle, consequently they are equal, and if a body is found to roll down the incline from B to A in 5.657 seconds what is the gradient for this time. We know that the height $B\ C$ will be in proportion to $B\ A$, as the square of the time of G in falling from D to A is in proportion to the square of the given time 5.657 seconds. The length of the radius $D\ A$ is 64.32 feet, or the height h from which the body will fall is 64.32 feet, and as $\frac{g\,t^2}{2} = h$, is must follow that $h \div \frac{g}{2} = t^2$, therefore $\frac{64.32}{16.08} = t^2 = 4$; and the square of 5.657 is equal to 32, and from this we see that the gradient is at the rate of 4 in 32 or 1 in 8, or if $A\ B$ is 64.32 feet long the height of $C\ B$ is $\frac{64.32}{8} = 8.04$ feet.

When the length of the incline and the ratio of the gradient are given, the time is easily found, because it is only required to reduce $\frac{g}{2}$ by multiplying it by the fraction of the gradient as in this case $16.08 \times \frac{1}{8} = 2.01 = f$ and therefore $\sqrt{64.32 \div 2.01} = t = 5.657$ seconds the time for a body to roll down an incline of one in eight, or the length $B\ A$.

The example at the bottom of the figure is to show that nothing falls but the load in cars running on an incline.

Here are two pans each weighing 1.5 tons, and marked W and S; W carries a load of 3 tons, therefore the pans and their load weigh conjointly 6 tons but only 3 tons fall, while the two pans balance each other, and are moved by the load. The pans are seen to be suspended by the rope passing over the pulley P. We see then that 3 tons have while falling, to set 6 tons in motion, therefore it is clear that the load will only acquire $\frac{3}{6}$ of the square of the velocity that would be attained, if the load fell alone.

It is clear then that the time on $N\ M$ must be longer than it was on $B\ A$ where a ball rolled down. In the first case f was $= \frac{g}{2} \times \frac{1}{8}$, now it is equal to $\frac{g}{2} \times \frac{1}{8} \times \frac{3}{6} = \frac{g}{2} \times \frac{1}{8} \times \frac{1}{2} = \frac{g}{2} \times \frac{1}{16} = \frac{g}{32} = 1.005$, and the time is $\frac{64.32}{f} = \frac{64.32}{1.005} = t^2 = 64$ and t is therefore equal to $\sqrt{64} = 8$ for the incline $N\ M$ with balanced pans, whereas, with the simple fall on $B\ A$, the time was 5.657 seconds. The gradient of the incline $N\ M$ can be found, as was explained in a former example, with this qualification however; the time of the fall from X to M must now be found by $\frac{g}{2} \times \frac{3}{6} = \frac{g}{2} \times \frac{1}{2} = \frac{g}{4} = 8.04 = f$, then $\frac{64.32}{8.04} = 8$, equal the square of the time in seconds for a body to fall from X to M with f force and it has been shown that it would require 8 seconds for the cars to perform the journey from N to M, but the height and hypotenuse of the gradient are as the squares of the times, therefore $\frac{8^2}{8} = \frac{64}{8} = \frac{8}{1}$, and if $N\ M$ is 64.32 feet, $T\ N$ must be $\frac{64.32}{8} = 8.04$ feet.

59. **Laws of Resistance on Inclines.**—Fig. 103 is to show that a self acting incline will run as fast with two, as with a hundred and two cars, if the friction of the rope and rollers, and the weight of the rope is neglected, because f is the same; and to make the matter clear, suppose the weight of each pan in the figure to be 1 as at B, and suppose the load to be 2, then $2 + 1 + 1 = 4$ the weight to be moved, and 2 is the weight that falls, therefore f must be $\frac{g}{2} \times \frac{2}{4} = \frac{g}{2} \times \frac{1}{2} = \frac{g}{4} = f = 8.04$. This value applies to the pans $A\ B$ on the pulleys P_1 P_2, and we will find the same value for f on the load on the pulleys P_3 and P_4. On the end of the rope C are four empty pans, and on the end of the rope D are four laden pans, but 4 pans balance 4 pans and the load falls, therefore f must be $\left(\frac{2 \times 4}{(2 \times 4) + (1 \times 8)}\right)\frac{g}{2} = \frac{g}{2} \times \frac{8}{16} = \frac{g}{2} \times \frac{1}{2} = \frac{g}{4} = f = 8.04$ as before. It is possible that two cars with one load could not overcome the friction of the rope and rollers, or lift the fraction of the weight of the rope due to the inclination. Any acceleration then due to an increased number of cars in a train is the result of a reduced proportion of friction, and not to any increase of f. We cannot dismiss this figure without showing that it is a beautiful illustration of Ohm's law, as applied to the current strength of the cells in a galvanic battery.

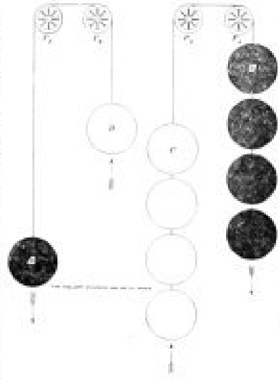


Fig. 103.

Ohm's law is this: "The current strength is equal to the electro-motive force divided by the external plus the internal resistance."

On a self acting incline the *motive* force is $\frac{g}{2}$ and the haulage strength is equal to $\frac{g}{2}$ multiplied by the load and divided by the load plus the weight of the cars, plus the proporton of the load due to the friction of cars, rope, and rollers. Now the friction of rope and rollers, corresponds to the external resistance, or resistance of the circuit wire, and the friction per car corresponds to the internal resistance per cell, therefore, we clearly see that as g and f represent inert force, Ohm's law could not apply to the conduct of an electric current unless that current was subject to the laws of inertia.

For example, suppose we have 10 cars in each of the two trains and that each load is equal to 2 tons and that each car weighed 1 ton as in the former example then,

$$\frac{2 \times 10}{(2 \times 10) + (1 \times 20)} = \frac{20}{40} = \frac{1}{2},$$

that is, f is equal to $\frac{g}{2} \times \frac{1}{2} = \frac{g}{4}$. Take a Leclanche battery of 20 cells and let the electro-motive force per cell be equal to 1.5 volts, and let the internal resistance be .5 ohms, the current strength for one cell is $\frac{1.5}{.5} = 3$ when the external resistance is *nil*, so $\frac{1.5 \times 20}{.5 \times 20} = 3$ as before; but suppose the external resistance is 5 ohms, then for one cell $\frac{1.5}{(.5 + 5)} = \frac{1.5}{5.5} = .27$ ampere and for 20 cells the external resistance remaining the same we have $\frac{1.5 \times 20}{(.5 \times 20) + 5} = 2$ amperes.

In precisely the same way, the friction of rope and rollers is easier overcome by larger trains; or suppose the resistance due to the friction of the rope and rollers is equal to 100 pounds, then for one load to move or run it must first overcome the resistance of 100 pounds, and if there are 20 loads, or 20 cars in a train instead of one, the 100 pounds will be equally shared among them and $\frac{100}{20} = 5$ pounds per loaded car.

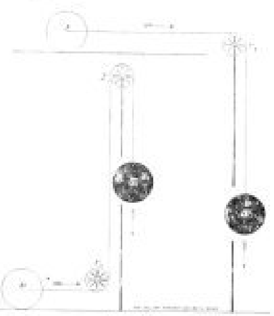


Fig. 104.

Fig. 104 illustrates how the time on an incline can be reduced by accelerating the velocity of the falling load at the beginning of its descent by making the empty cars first move along a short level. To explain the matter, let the load be 2 as before, and the weight of an empty car 1. Then by the figure at $A\ C$ or $B\ D$ we see that B and its load fall, while D is only moved along a horizontal plane, and therefore its center of gravity is neither raised nor lowered, and we now see that 4 tons are moved while 3 tons fall, thus making the value of f equal to $\frac{g}{2} \times \frac{3}{4} = \frac{3g}{8} = 12.06$.

By the figure, P_1 and P_2 are two pulleys for one rope, and therefore set up an increased resistance, which if duly allowed for, should reduce the value of f.

Fig. 105 shows in contrast two modes of accelerating the initial speed of trains on self-acting inclines, and in some cases both the "level foot" and "cycloidal head" are combined in one haulage. At $B\ D$ we have the cycloidal or quick fall at the head of the incline. This quick fall at the head however is not at all times possible in a mine, consequently the level at the foot is substituted, as $E\ H$ is easier made, but like all such artifices their advantages are very doubtful, for to obtain increased grade at the head you must reduce the grade at the foot of the incline, and when the laden train is near the bottom its energy is often so exhausted with the brake or some other resistance, that it is unable to raise the empty train onto the brow of the incline, and the consequence is, such stoppages waste more time than that gained by acceleration with "cycloids" or "foot levels," as $B\ D$ and $E\ H$; and the result of all this is that $A\ B$ with a mean fall $B\ C$, or $E\ F$ with a mean fall of $F\ G$, often give the best practical results. There are however special cases where the "foot level" and the "cycloid" can be used with advantage.

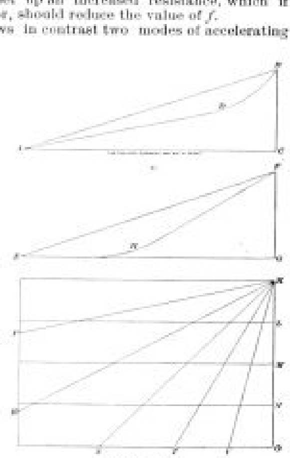


Fig. 105.

60. Times and Velocities on Inclines.—The lower part of the figure is to illustrate a point wherein it is manifest, that nature never conflicts with herself; and to make the point clear, let us notice that the same weight or mass of matter always contains the same amount of energy when moving at the same velocity as that at which it has moved before, or every time a one pound mass moves with a velocity of 32.16 feet per second, it has stored up in itself neither more or less than 16.08 foot pounds of energy, and with equal truth it can be said that when a mass has fallen (without friction) to a depth of 16.08 feet, whatever may have been the angle of the inclination or the grade, in every case, without exception, when the descent has become equal to a vertical fall of 16.08 feet, the velocity at which the mass is moving is 32.16 feet per second. *L*, *M*, *N* and *O*, are horizontal lines to indicate the depth of fall. *P*, *R*, *S*, *T* and *V*, are inclined lines from *K*, to indicate different grades of inclination. Now *P*, *R*, *S*, *T*, *V* and *O*, all cut the horizontal line *L*, and if bodies were made to roll down *K O*, *K V*, *K T*, *K S*, *K R* and *K P*, to *L* they would arrive at different times, and all the times would be found to be proportionate to the square roots of the lengths of the inclines. The velocities would also be found to be the same when the bodies rolled down the inclines to the levels *M*, *N* and *O*. It does no doubt appear to a student strange, that the times are different, and yet the velocities are the same, when all the bodies have fallen from the same elevation to the same level; but the strangeness disappears when we learn that it *must be so*, for if the velocities were different, the stored up energy would be different, it therefore follows, that, whether the time is long or short, when a body has fallen through a given vertical depth, the velocity at the end of the time is same as though it had fallen in a vertical line instead of an inclined one.

Nothing perhaps is more interesting in relation to the behavior of falling bodies, than the fact, that a body will roll along the line of a curve in less time than it will do the same fall along a shorter path in a straight line; or a body will roll along a curve *B*, *L*, *C*, *H*, *A*, in less time than it will roll along the straight line *B*, *A*, Fig. 106. This is the noted example of the "law of the cycloid" in relation to falling bodies, and to explain the matter with clearness, let us by "plain figures" for "easy lessons" work it out, step by step.

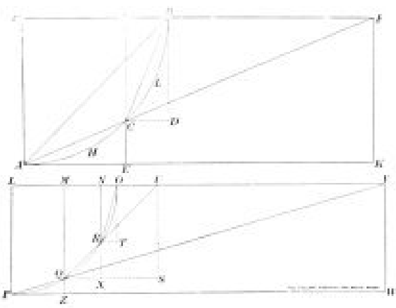


FIG. 106.

The angle *BAE* is one of 45° therefore the sine is .7071 and f is $= \frac{g}{2} \times .7071 = 16.08 \times .7071 = 11.37 +$

Let the vertical line $GA = 100$ feet then BA will be equal to 141.42 feet and as l is the length,

$$\sqrt{\frac{l}{f}} = \sqrt{\frac{141.42}{11.37}} = t = 3.53 \text{ seconds nearly,}$$

the time for a body to roll down the straight line *BA*.

To attain accuracy for the time on the curve, we would have to plunge into very advanced mathematics, but we can come very near to the time with plain figures, and by this means explain the case better.

Let us then try first to find the time required for a body to fall along the line *BC*, and we will therefore require to know the length of *BC* and *BD*.

Now *BGC* is an angle of 45° therefore the sine is .7071 and the chord *B C* is .76536 or the actual length is 76.536 feet, and f is in this case $= \frac{g}{2} \times \frac{.7071}{.76536} = 14.85$, then the time for *BC* is equal to

$$\sqrt{\frac{76.536}{14.85}} = t = 2.274 \text{ seconds.}$$

It would be thought by the uninitiated that the body would be longer in rolling from *C* to *A*, than in rolling from *B* to *C*, but such is not the case, because the velocity the body has attained at *C*, is twice that of its mean velocity in rolling down *BC*, for it started with no velocity, and if it had no fall from *C* to *A*, it would still move through that distance in less time than it required in falling from *B* to *C*; indeed it would do it in less than half the time, as we will just now prove.

By the figure, the vertical line *F K* is equal to *G A*, and as *A C* must be equal to *C B*, it follows that *A C* is 76.536 feet, and as *C E* is proportionate to the versed sine of 45°, it is 29.289 feet long. We are now in a position to find the time a body will be in rolling down *C A*, because if a body rolls down *F A*, by the time it reaches *C* it will be moving with the same velocity it would have at *C*, if it rolled down *BC*. Again, if we could find the times for *FC* and *FA*, the difference would be the time for *C A*. The length of *A F* is found as follows: $AC = 76.536$, $CE = 29.289$, and $FK = 100$. Therefore,

$$AF = \frac{76.536 \times 100}{29.289} = 261.35 \text{ feet.}$$

Now f will be equal to $\frac{g}{2} \times \frac{29.289}{76.536} = 6.1535$, and the time for *F A* is $\sqrt{\frac{l}{f}} = \sqrt{\frac{261.35}{6.1535}} = 6.5171$, and the time for *F C* is $\sqrt{\frac{l}{f}} = \sqrt{\frac{(261.35 - 76.536)}{6.1535}} = \sqrt{\frac{184.814}{6.1535}} = 5.4803$.

Time from *F* to *A* = 6.5171
Time from *F* to *C* = 5.4803

Time from *C* to *A* = 1.0368 seconds.

Time from *B* to *C* plus *C* to *A* is equal to 2.274 + 1.0368 = 3.3108 seconds, and the time for *B A* was 3.53 seconds, and the difference is 3.53 − 3.3108 = .2192, or rather less than a quarter of a second. In the lower portion of the diagram, the times for *O R*, *R Q* and *Q P* are found by the same process as *B C* and *B A*.

It is true that the curve we have used was not a strictly correct cycloid, nor have the advantages of the cycloid been shown in reducing the time on a longer line after leaving the curve, but for mining purposes, it may be said that all we require for an incline is a good fall at the top and a short level at the bottom.

[TO BE CONTINUED.]

MINING METHODS.

Local Ventilation—Pressure in Ventilation.

54. Local Ventilation.—In mining coal by different methods of long-wall working we soon find that special conditions require appropriate treatment, for we cannot work the coal in many cases by ideal plans, but by such modifications as will adapt the method to the requirements that arise in each case.

Longwall workings are said to be easier ventilated than those of pillar and chamber, or otherwise board and pillar, or room and pillar, and this statement is quite true so far as the removal of fire-damp is concerned when the working face is advancing up-grade, but you may so run the line of the face as to make a *pool* for the collection of gas, and actually make danger where it ought not to exist. We admit that longwall is easy to ventilate, but for all that, the system has its peculiarities and if they are not understood, they cause trouble; for example, the roof breaks and falls, and the fissures and cavities thus made become reservoirs for the storage of very large volumes of gas, which float out of the old rear workings during the progress of a depression in the atmospheric pressure; the result is, it is at all times dangerous to fire shots either in the gateways or at a longwall face, so that "easy to ventilate" does not at the same time mean freedom from danger, unless due care is exercised to prevent the possibility of gas stratifying at the working face. In Fig. 99 we have an example of this kind; the working face is advancing up-grade, as shown by the pitch arrow at *P*, and the ingoing air is seen to be conducted up the principal gateway *F H*, and the impure air is made to return by the two flanking gateways *A* and *C*. Now the danger in a longwall working of this kind arises when the middle intake airways are advanced too far ahead of the flanking gateways, for then gas accumulates as in a pool or bay contained within the dotted line *A*, *B*, *C*.

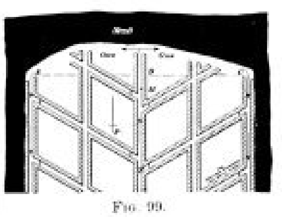


FIG. 99.

Fig. 100 represents a longwall face under conditions the opposite of that of the previous figure; for here, the flanking gateways are in advance of the middle and principal gateway, and as far as the ventilation is concerned, it appears to correct the defect shown in the previous figure, but on closer inspection it will be observed, that one defect has been substituted for another; for now we destroy the coal to remove the gas, for it will be seen that to keep the advance of the middle gateway behind that of the flanking returns, the coal "jetties" or juts out in front of the dotted line *A*, *B*, *C*, and under such a condition of strain it is crushed and spoiled. The pitch of the bed in this case is indicated by the arrow *P*, the main intake is shown by *D G*, and the return gateways are seen at *E* and *F*.

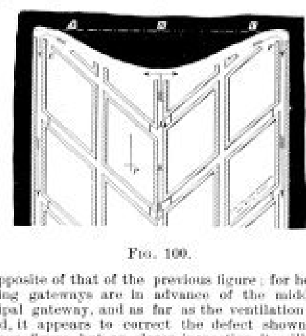


FIG. 100.

The ventilation of a longwall face may be "easy," but it cannot be well done without a well matured judgment and in a case like that shown in the last figure or the previous one, where the face is advancing upgrade the greatest defect is found in conducting the ingoing air up the middle gateway instead of up one of the flanking gateways, say in the figure before us *E*. Now if *E* has to be the principal intake airway, for the best possible ventilation of the working face it must be kept in the rear of *F*, or *F* must at all times be advanced higher upgrade than *E*, so that all gas will *rise* along the face on its way to the return. This then is another example of the fact that in mining, to secure success, careful and critical judgment is required to find one condition that will not conflict with the other unalterable ones.

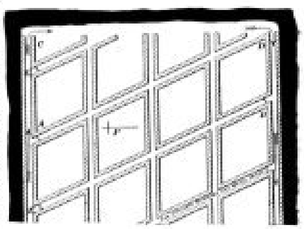


FIG. 101.

Fig. 101 is an example of a longwall working face advancing along the strike instead of upgrade on the line of pitch; and where such an arrangement can be carried out, the very best results are obtained, in so far as ventilation and the removal of gas is concerned; pack walls are never gas or air tight, and any gas escaping out of the old workings can always be collected in the return airway that skirts the top edge of the goaf, beside, no gas can loiter in the neighborhood of the working face as it must float up to *D*.

In good mining practice longwall working is varied to meet all the conditions that are met with in the roof and the floor, and all the variations in the "texture" or quality, or the closeness or openness of the cleavage planes in the seam, and the tenderness or toughness of the coal. Such being the case we must never prefer any system or any modification of a system, but practice all or any system, or any modification of a system that best fits the conditions that we are confronted with.

The arrow *P* gives the direction of the line of dip; *D B*, is the main return airway; *E A G*, is the main intake airway. At *G*, *A* and *B* we have doors; at *E* is a permanent brick stopping. At *C* we have the dip or lowest point of the face, and at *D* is situated the rise or highest point of the face.

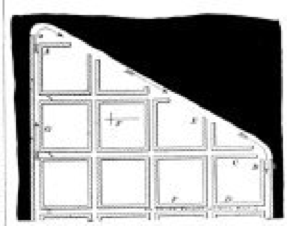


FIG. 102.

Fig. 102, brings before our notice another modification of longwall. In the shales we find cleavage planes that are common in slate and coal deposits, the shales and the slates may, however, be classed as one, because true slate is only metamorphosed shale. The cleavage planes were made before the constituent clay of the shales, or the bog of the coal seams, was indurated.

We can quite account for the cleavage planes in shales and coals, but to the uninitiated it will appear strange to learn that the faults, fissures, and master joints in the limestones and sandstones were produced by lateral pressure in the earth's crust just as were the cleavage planes, but let us clearly comprehend that the fine lamination produced in plastic clay, must be different from the cracks and fissures in a *broken* solid, and it is with the latter we have to deal in explaining the reason of this modification of longwall working in coal.

We cannot but expect that the common parallelism of the faults and joints in the rocks overlying the coal seams will seriously affect the cost of obtaining the coal, unless the mode of working is adapted to the conditions of the roof; for example, if the line of the face is parallel to the lines of the faults and roof joints, the cost for labor in removing fallen stone, in the timbering and retimbering of the workings, and the extra labor and danger attending the cutting and filling of the coal will conjointly render the working of such a mine an unprofitable transaction.

The modification shown in the last figure is adopted where the master joints are running from *C* to *D*, and from *E* to *F*, and are not parallel to the lines of any of the pack-walls, but have a direction making very nearly a right angle with the line of the working face.

It will be seen that the principal intake airway is *G A*, and the return is at *B*, and that the cover will fall off the coal face and thus prevent undue pressure and damage, while any gas from the goaf will be carried off at once into the return. The arrow *P* shows as before the direction of the pitch.

55. Pressure in Ventilation.—Pressure is an important factor in mine ventilation, and however much men may err in judgment concerning it, the law of its action is constant. Many years ago bore holes were suggested and tried as channels for the escape of the light gases given off by coal. It was said "marsh gas is light," therefore if a bore hole is drilled down into the highest point in a goaf where this gas accumulates it will float up the hole and thus clean out all the gas, but the gas never would rise because the hole was invariably a downcast for air, and if we pause for a moment to consider the case we cannot fail to see, that the behavior of the air was neither eccentric nor erratic, but subject to the action of an invariable law; the air was pressed down the bore hole because the pressure in the mine was less than the atmospheric pressure at the surface. There can be no doubt that the bore-hole will in the near future be an important aid to ventilation, because it furnishes the cheapest and most efficient way of removing inflammable gases from old workings or goafs with a very small quantity of air.

Where mines are not very deep and the holes can be readily made, we can discover without much argument that they must be a good investment. With the furnace and the exhaust fan, bore-holes cannot be adopted as aides to ventilation, for the current pressure at the bottom of the downcast shaft will always be less than at the surface, and in the case of an exhaust fan the pressure in the mine near the upcast will be considerably less than at the surface; this fact is clearly illustrated by Fig. 103, where for illustration, a recess is seen at R W to illustrate rise workings where gas has accumulated, and a bore-hole has been drilled for the escape of the gas, but the result is contrary to the intention, for the hole is a downcast as shown by the arrow at H.

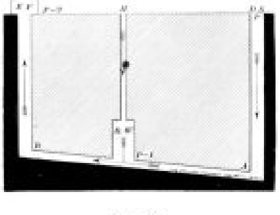


FIG. 103.

At the top of the upcast shaft the exhaust fan E F is seen, and let P represent the surface pressure, and $P - 1$ represent the reduced pressure in the chamber R W, and further let $P - 2$ represent the depression in the fan drift, a moments consideration will satisfy us that the air cannot do any other than rush down the bore hole into an inferior pressure as is shown in the illustration. Again let us reverse the ventilating action by using a blowing, instead of an exhausting fan, as at B F Fig. 104, the blowing fan at the mouth of the downcast shaft. It will now be seen that instead of $P - 2$ we have $P + 2$, and instead of $P - 1$ we have $P + 1$ the result is as we may expect, the gas is blown up the bore-hole H, as shown by the arrow.

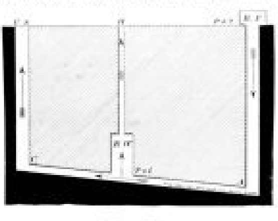


FIG. 104.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

Electro Metallurgy of Copper.—Electric Polarity.

57. Electro-Metallurgy of Copper.—Copper ores yielding about 6 per cent. of metal, can only be made to yield a profit in two ways; first, when the ore is available in the "open," and labor is very cheap; and second, when the metal can be cheaply separated from its stony matrix and chemical combination by electrolysis, or electro metallurgy as applied in mining. It is to explain the second process that the subject illustrated by Fig. 94 has been introduced. At D we have an electrolytic or really a Daniels cell, for in the porous pot or diaphragm is a week solution of sulphuric acid along with the zinc element B, and along with the carbon or copper element is a solution of copper sulphate $CuSO_4$, at A. During the action of the cell (which is very slow) unless it is aided with a current of some voltage, a deposition of the metal copper takes place on the carbon or copper element, and if copper plating is required, the metal can be made to deposit on the surface of another metal, or even on the surface of wood coated with charcoal or any other electric conductor. The voltaic current is seen to circulate through the wire W, beginning at C, and returning by Z. T T is a tank such as is used for separating metallic copper from a solution which may be a chloride or a sulphate. G G is the surface of the liquid and pieces of scrap or pig iron are seen covered with the solution. In Spain and Portugal it pays sometimes to flood the copper mines, and pump the sulphate into such tanks as we illustrate and deposit the metal copper on pig iron, from which it is afterward removed by water when the metal is collected as a brown powder. Sometimes advantage is taken of electrolytic action by first pouring onto large heaps of the ore considerable volumes of water, after which the drainage from the heaps is pumped up into tanks containing pig iron as before.

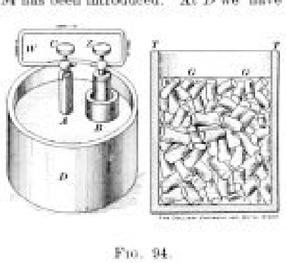


FIG. 94.

The tanks are really electrolytic cells, and the mine and the watered heap are in fact the laboratories where the sulphate of copper is prepared to feed the cells.

Fig. 95 is introduced to illustrate the laws of electric and chemical polarity.

In making a first acquaintance with magnetic, electric and molecular polarity, the student is surprised to find the strong co-relationship of (what shall I say) the polarities or the the polarity of force. At A we have a simple cell and the carbon C and the zinc rod Z, are called the poles in reference to the wire or galvanic circuit, and in reference to chemical action they are called the elements, and the positive pole $+P$ is in the cell, the negative element —, and the negative pole —N is in the cell the positive element as shown at E and E, and the current is seen to start at Z in the cell and pass on to C, and to pass out of the cell from C to Z. At B we find an example of chemical polarity, the exciting liquid is dilute sulphuric acid H_2SO_4 and the positive element zinc is seen to repel the positive hydrogen which clings to the copper plate as globules H, H, H, while the negative SO_4 combines with the zinc as sulphate of zinc, $ZnSO_4$. In this and all other examples in chemical action, the atoms and molecules combine by polarity. Positive combines with negative, and in this case the positive zinc has displaced by repulsion, just as a magnet would do, the positive hydrogen. C is an example of a battery of cells and to secure an increased electro-motive force the cells are combined on the basis of a correct polarity, by connecting the negative pole of one cell with the positive pole of the other.

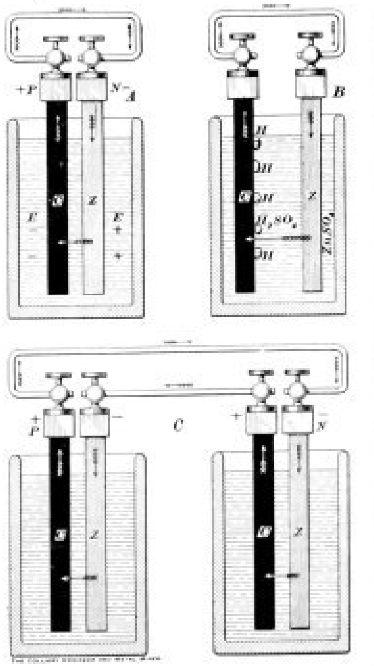


FIG. 95.

58. Electric Polarity.—Fig. 96 brings before our attention an example of electric polarity as manifested by the same current when a part of it is moving in one direction and the other part is moving in the opposite direction by an arrangement of the circuit wire. When currents are made to move in parallel lines, the laws of polar action are: currents moving in the same direction repel each other, and currents moving in opposite directions attract each other, and the case before us is one of repulsion.

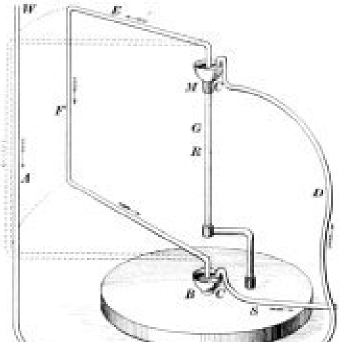


FIG. 96.

The construction and mode of action of the instrument requires some notice: In the first place it will be seen that to prevent a break in the continuity of the current two cups of mercury are used as at M and B or C and C. The movable loop B F E is made to dip with both its ends into mercury, while the downgoing portion of the circuit, or electric channel W is made to conduct the current into the upper cup of mercury, when it enters the upper end of the movable loop and flows down into the lower cup, from where it passes on to the battery. The rod G R is an insulator. The current is seen in this case to act repulsively on itself, or the fixed portion of the circuit W is repelling, and is itself repelled by the side of the movable loop. It will be seen that W D C is the electric channel leading to the upper cup and the continuation is M F B S. Fig. 97 is an illustration of the arrangement of the circuit wires in the same instrument to set up attraction; and now the wire W is put into circuit with the bottom cup B, the result is the electric stream flows up the side of the movable loop B F E, while the return wire D becomes S in this arrangement. This polariscope therefore establishes the fact that currents in the same direction repel and currents moving in opposite directions attract each other as in the figure.

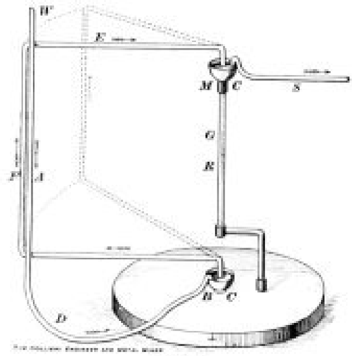


FIG. 97.

59. The Magnetic Tick.—That the modes of motion known as electricity and magnetism are the results of certain harmonic movements of the molecules in the mass of a magnet or an electrical conductor, cannot be doubted, because the conclusion is sustained with direct proof. Construct an apparatus such as that shown by Fig. 98 and by this means we are made able to hear molecules striking each other.

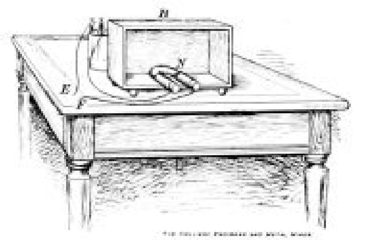


FIG. 98.

The construction and mode of action are as follows: The resonance chamber is adapted out of a cigar box as shown at B, and nothing better can be used for reflecting and conducting otherwise inaudible sounds than dry wood, as notice the microphonic sounds heard with the telephone. Lying on one side of the resonance chamber or cigar box, is an electro magnet and helix N, and the circuit wires are seen to come from a galvanic cell, and the circuit is broken at E F.

If the ear is held close to the resonance chamber, the moment the wires E and F are made to touch each other a distinct *tick* is heard, and the moment the wires are detached and the circuit is broken the tick is heard again. The tick produced, as we may imagine, with a strong current, is louder than that produced with a weak one. The tick has a peculiar ring and has to be heard to recognize its true character. When iron is magnetized it expands as though it was heated. There are no doubt some simple laws controlling and differentiating motion to produce its modes, and if our eyes were sufficiently microscopic that we could see the molecule-dance for light, heat, electricity, magnetism, and chemical action, we would be able to identify these inflections and associate them with well-known mechanical laws. From all these experiments it is obvious that to master this subject we must clearly comprehend that we are dealing with manifestations of force, that are only different in their mode of action. This brings us to consider again the polarity of attraction and repulsion as we find it in generating "magneto electricity," and here be it observed that, as has been already shown, if a circuit wire is coiled on the *soft iron* legs of a revolving armature, as the ends of the legs approach the opposite poles of a *permanent* magnet a momentary induced current flows in the directions of the arrows at A, Fig. 99. N is the north and S is the pole of the inducing permanent magnet; M and P are the legs of the revolving armature, and G is the spindle on which the armature revolves.

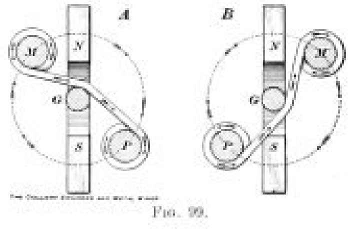


FIG. 99.

At B the legs of the armature M and P are leaving the poles of the permanent magnet N and S as before, and the result is, the induced current moves in the opposite direction, but it must be *very* carefully noticed that there are not four positive and four negative electric pulses in one revolution of the armature; for, see at *B*, *M* moves from *N* onto *S* without changing the sign of the pulse, and *P* moves from *S* on to *N* without changing the sign of the pulse. At *B*, *M* from *N* is the same direction of the current as at *A*, where *P* is advancing on to *S*. In the next figure we have to notice that there are minimum and maximum points of induction. At the moment when the poles of the armature begin to depart from the poles of the magnet, induction begins and swells up to the crest of the electric wave, as graphically denoted by the letters *N* and *S* at the top of Fig. 100 where *D*, *N*, *Z*,

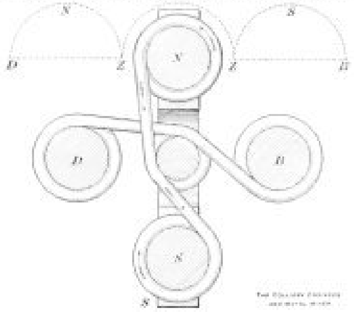


FIG. 100.

is one pulse wave and *Z*, *S*, *B*, is another. Suppose the armature to be revolving in the direction of the hands of a watch, then the tendency is for the current to flow one way, and yet if there is a considerable distance between the poles one pulse tends to have two maximum and one minimum point, and this, we shall afterwards have to show develops waste of energy.

Fig. 101 is an illustration of the mode of action of the

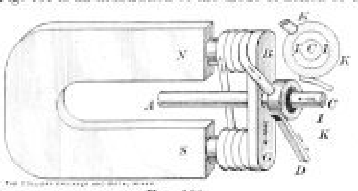


FIG. 101.

magneto electric machine used for generating either muscular or nervous action, or both, in the bodies of sick people. *B G* is the armature which revolves on the spindle *A C*, one terminal of the wire coils is seen at *B*, to be in electric contact with a brass ring *K* which is insulated either with a wooden or gutta percha ring *I I* in perspective and vertical section, or on the spindle *C*, is a wood jacket to isolate *K*. The other end of the wire of the coils is in electric contact with the arm of the armature, and by that means with the spindle. Now a spring *D* is made to rest in contact with *K*, and the frame of the machine is in contact with the spindle, therefore the loop in the complete circuit has its terminals connected with *C* and *D*, and the body of the patient is made by means of handles on the outside wires to form part of the circuit. Further on a modification of *K* brings us to what will be called the commutator.

[TO BE CONTINUED.]

GEOLOGY OF COAL.

Life Conditions of the Earth.

48. Life Conditions of the Earth.—The life conditions that have characterized each successive period during the earth's long age have been the environments of the faunas and floras that were peculiar to the times; or it may be said, the life conditions of any one period were unfavorable to the characteristic life of all the other periods before it or after it. Just as now the great zones of the earth establish different environments for different varieties of plant and animal life, and if by any change the temperature of the torrid zone was lowered, its characteristic life would perish and become extinct for ever, for plants from the torrid zone can only be kept alive in the temperate zones with the help of heat artificially applied, and the plants of the temperate zones can only be kept alive in the torrid zone by cold artificially applied.

The torrid zone is the home of reptiles that live on the flesh of other animals that obtain their food almost without an effort; the temperate zones are the homes of the higher orders of mammals, that obtain their food by vigorous efforts, intelligently directed. The frigid zones are the homes of carnivorous birds, carnivorous beasts and carnivorous fishes, while the vigor of the climate is totally unfavorable to the growth of the plants of the temperate zones.

Had the earth's environment of life never changed, almost the same life forms would have been engraven on the bedding faces of the laminæ of the same varieties of the rocks; but such is not the case, because each period was subject to different climatic conditions that favored some and disfavored other life forms.

That different climates characterized different periods cannot be doubted, and it is evident that the whole earth at one period was subject to a tropical temperature, and this was especially so during the Carboniferous period. Rocks of this age are found in all the zones, even the frigid ones, and they are all marked with imprints like those of the tropical tree ferns and their associate cryptogams; indeed, the very existence of coal is an index of life conditions such as prevail in the torrid zone now. As practical men, we would not trouble about the climatic characteristics of the Carboniferous period, were it not for the fact that we can only distinguish the fossils of the period from those of other periods by intimately connecting them with the cause of their individuality. The climate then of the period is a peg on which hangs all our facts, and we cannot, therefore, consider the time ill-spent in a little more investigation of the matter.

Geology and astronomy are mutually dependent sciences. The one will never be understood until the other is made to harmonize with it by tracing geological changes to astronomical causes. For example, we have two theories concerning the relative ages of the planets; by the first one, the oldest planets are nearest the sun; by the second one, the youngest planets are nearest the sun. By the first theory the climate of the whole earth should be much warmer than it once was; by the second theory the climate of the whole earth should be colder than it once was. Geology furnishes unmistakable proof that the climate of the whole earth was hotter than it now is, and the first theory dispenses with this fact by pointing out that the young earth was a ball of liquid fire covered with a hard crust that was sufficiently hot to produce a warm climate, even when the planet was at a much greater distance from the sun; but geology entirely sets aside that conclusion and proves to us that glacial periods have been repeated during all the ages that have passed while the deposition of the stratified rocks was taking place, and we therefore discover that to have a comprehensive view of the earth's life history, we must be able to grasp with ease the peculiarities of the fossils that give to each group of rocks their special individuality; and for this purpose the entire series of rocks that constitute the crust of the earth have been divided into three great groups each of which are distinguished not only for stratigraphical traits but for their progressive successions of life, namely, the paleozoic, mesozoic, and cainozoic periods.

The fossils of the paleozoic period are the remains of such organisms as could only live in the waters of relatively hot seas, as notice the great prevalence of coral and crinoidal remains.

To show the entire dependency of the coral and crinoidal organisms on a high temperature for their existence, we must notice two great facts, first, the coral insects *cannot* live now in the waters of seas whose temperature is less than 60° *F*; and, second, the solubility of carbonate of lime varies as the temperature inversely, the result is as the temperature increases the solubility decreases, until lime is insoluble in boiling water.

Knowing this last fact we cannot wonder when we are told that the minimum temperature at which the coral insects can encrust themselves with their shell of lime is 60°F, because at lower temperatures the lime is increasingly soluble, and so much so, that the crust of the insect would dissolve as fast as it was secreted; and if heat is a prime necessity in the coralline seas, how much more must it be an indispensable condition in the environment of encrinital life. From the "testimony of the rocks" we learn that the floors of some of the paleozoic seas were covered with a stone flora.

We do not look for such life in our seas to day because we know this is a period that environs another variety of life. Lime in our cold waters is very soluble, but during Carboniferous times the high temperatures of the atmospheric and oceanic currents carried the heat factor of the environment of encrinital life within the polar circles, hence from pole to pole the rocks and their contents manifestly prove that the temperature of the paleozoic period was high. During the deposition of the Carboniferous series of rocks and especially the Lower Carboniferous limestone measures, the floors of some of the seas were like veritable submarine gardens of stone lilies, classed as echinoderms, indeed the calcareous peduncles supporting the corollas of the lilies, would resemble the spectacle of fields of grain.

We now know that we owe to corals, crinoids and foramanifers, the selection, collection and deposition of all the limestone strata of paleozoic times.

Many of the present most rudimentary life forms have come down from Cambrian times, their survival being due to their adaptability to the ever changing life conditions on the earth, and Fig. 77 furnishes two examples. At *S* we have a radiate organism or star fish; round about the central region is a circular nervous cord, and at the base of each finger or ray a nervous cord branches off from a ganglion or knot of nervous matter into the ray to control its movements. These creatures have rudimentary organs of vision, and altogether furnish a good illustration of that division of animal life called *radiata*. At *N* we have another living example of the survival of the oldest organisms, and this is one of the present representatives of the orthoceras called the nautilus, both belonging to the order cephalapoda or head-footed molluscs. It will be interesting to observe the successive changes in the organism of this creature in its survival of the mighty climatic oscillations through which it has passed.

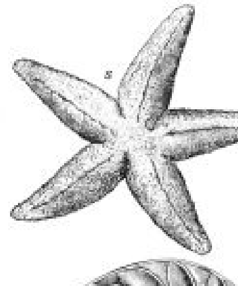


FIG. 77.

Fig. 78 is characteristic of the mesozoic, middle life,

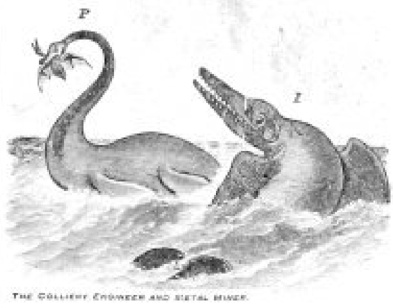


FIG. 78.

or really the reptilian peroid. Reptiles made their first appearance during Carboniferous times, but during the secondary period they swarmed in the air on wings and were the principal life forms on the land, the shallow waters, and the deep seas. The bird and the the reptile are closely allied, and the first bird form we are acquainted with, appeared during this period; its mandibles or jaws contained teeth, and in its wings were claws, so that it was after all allied to the reptiles such as the plesiosaurus *P*. The modern crocodile and the alligator are the modern representatives of the ichthyosaurus *I*.

The mesozoic period was the reptilian age *par excellence*, and this furnishes strong proof of the prevailing high temperature of the period, for these cold blooded creatures are only represented by diminutive examples in high latitudes. In hot regions, however, reptilian life is prolific, and it is here also that the most powerful representatives are found.

Fig. 79 introduces us to the life and climate of the

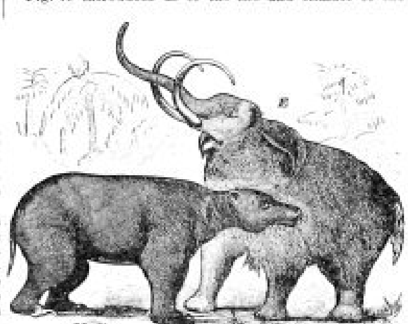


FIG. 79.

cainozoic period, and here the mammalia replace the reptilia, or reduce them to the representative examples we know, such as the lizards, snakes and serpents, and especially those of the region of the torrid zone. Many of the forerunners of the true mammals, the marsupials, have become extinct, and many species of mammals have perished during great climatic changes. The megatherium *M* was one of this class, and the genus elephanti, of which the mammoth *E* is an example, once consisted of a number of species, all of which have become extinct except the elephant. It is clear that the mammoth perished during the last glacial period, for an example, covered with hair and flesh in a state of considerable preservation was found a few years ago locked up in frozen ice and mud. The life of the cainozoic period is the highest in the organic scale, and is subject to the conditions of a lower mean temperature; and as we have urged the importance of studying the past life of the earth from the stand-point of higher temperatures than prevail now, we will continue the subject as far as it will assist the learner to grasp and retain the recollection of the life forms that are of undoubted importance in the interpretation of that geology that especially concerns us in mining.

[TO BE CONTINUED.]

The Niagara Power number of Cassier's Magazine is unquestionably the handsomest special edition of any publication ever issued in America. Its literary merit is fully equal to its artistic appearance. In the matter of illustrations the number is particularly remarkable. The contributors are all men of national reputation in their several specialties, and they have prepared their articles in a manner that makes them not only very instructive, but entertaining as well. The publishers and editor in getting out this special number have won for themselves great reputations for enterprise and liberality. Long life to Cassier's.

MISCELLANEOUS.

THE DEPTHS OF SPACE.

Of all the sciences there is none which makes such vast demands upon the powers of the human imagination as the science of astronomy. We have to brace our minds to the conception of distances and magnitudes so utterly transcending all ordinary human experience, that special means have to be invoked to render them intelligible. Each advance in our knowledge of the heavens reveals to us the grandeur of the celestial spaces on an ever-growing scale.

The great majority of the stars are situated at distances so enormous that it is utterly hopeless to attempt to determine how far away they are. In fact, only comparatively few stars happen to lie sufficiently close to the earth to permit of making any accurate determination of their positions. Nor is it by any means an easy task to choose out these particular objects which do lie within range. It not unfrequently happens that after much labor has been expended on observations of some particular star, it has been found that the work is fruitless, and that the star is so remote that there is no possibility of learning what its distance actually amounts to. It might naturally be supposed that the brightest stars are those nearest the earth; and no doubt if all the stars were intrinsically equally bright their apparent brightness would be a safe guide in placing those objects at their true relative distances. But there is no such simple connection between brightness and proximity as this would imply.

There is, however, another indication of position which is very frequently accepted by astronomers when discussing whether a star is likely to lie within such a degree of proximity to the earth as to make it worth their while to try to determine its distance. When we are looking at a steamer near the horizon the vessel seems to change its place but slowly, though we may know as a matter of fact that it is traveling at a rate of perhaps more than ten miles an hour. The nearer we are to the steamer the more rapidly does it seem to move. In like manner, if a star were animated by what is called proper motion, that is to say, if the star shifted its position on the sky with reference to the other stars, and if the amount of this shift was unusually great, then there would be a presumption that the star was comparatively near. It will, indeed, be obvious that if all the stars were really travelling at the same speed, those which lie nearest the earth would move over an appreciable part of the sky in a shorter time than those which were more remote. Of course, we are not entitled to assume that the stars are moving with equal rapidity in space. Indeed, we know well, that such is not the case. But, speaking generally, we may fairly argue that if a star does appear to be moving rapidly, it is a presumption that the body is one of the sun's nearer neighbors.

The star whose distance is to be sought having been chosen, the astronomer measures in his telescope the sky interval by which that star is separated from a neighboring star, which, though apparently close by, is in reality much further away. It is however, essential that the two shall lie so nearly in the same direction as to be both visible together in the same telescopic field. By means of a delicate instrument applied to the telescope we measure the width of the bit of sky between the two stars, and these measurements are repeated night after night for a twelvemonth. This years' series of observations is absolutely necessary, for the astronomer is gradually shifting his own position, and in six months' time this shift will amount to nearly 200,000,000 miles, the earth having moved during this period round to the opposite point of its orbit. The displacement of the observer alters the position of the near star in relation to its more distant companion. We thus find that the sky interval between the two objects changes periodically, and by observations such as these it is possible, by the magic of mathematics, to determine the distances of some of the stars from the earth.

A due appreciation of the magnitude of these distances is poorly conveyed by strings of figures representing millions of miles. Electricians know that the speed of the electric current on a telegraph wire is about 180,000 miles a second. If then an electric wire encircled the globe seven times, we should then find that an electric signal sent into the wire at one end, would accomplish the seven circuits in one second of time. Provided with this conception we can now give suitable illustrations of the results at which astronomers have arrived in their researches on the distances of the stars.

Let us suppose that the telegraph lines, instead of being merely confined to the earth, were extended throughout the length and depth of space. Let us now see what the very shortest time would be in which a message might be transmitted to each of these several destinations. First with respect to the moon, our satellite is comparatively speaking so near to us that but little more than a second would be required for a signal to travel thither from the earth. The sun is, however, so far away that when the key had been pressed down, and the electric wave had shot forth along the solar wire to pursue its route at that stupendous speed which would permit it to place a girdle seven times around this earth in a second, yet eight minutes would have to elapse ere the electric wave, had passed from the earth to the sun.

Telegraphing to the stars would be a much more tedious matter. Take first the case of the very nearest of those twinkling points of light, namely, Alpha Centauri. The transmission of a telegraphic message to this distant sun would indeed tax the patience of all concerned. The key is pressed down, the circuit is complete, the message bounds off on its journey to a distance so overwhelming that the time required for the journey is not a question of seconds, or of minutes, not of hours, not of days, not of weeks, nor even of months, for no less than four years would have to pass by before the electricity, trembling along the wire with its unapproachable speed, had accomplished this stupendous journey.

Alpha Centauri is, however, merely the nearest of these stars. We have yet to indicate the distance of those which are more remote. Look up to-night toward the heavens, and among the thousands of twinkling points which delight our eyes there is many a one up there so far off that if, after the battle of Waterloo had been won in 1815, the Duke of Wellington had telegraphed the news to these stellar depths, the message would not yet have been received there.

Over our heads there are thousands of stars, which can only be seen through the telescope, and they are so remote that if the news of the discovery of America by Columbus had been circulated far and wide through the universe by the instrumentality of the telegraph, the announcement would not yet have reached them; and it seems certain that many of the stars, which are known to us only by the impressions they make on a photographic plate, are so remote that if the glad tidings of the first Christmas at Bethlehem, 1,894 years ago, had been disseminated through the universe by the swiftest electric current ever known, yet—those stars are so inconceivably remote—all the seconds which have elapsed in the 1,894 years of our present era would not have sufficed for the journey.

Some there are who may be inclined to doubt these facts, and of course to doubt wisely is a most wholesome attitude to take with respect to all scientific work. But such should remember that space seems to us to be boundless, for our imagination can conceive no limits. There must, it would seem, be depths of space thousands of times, or indeed millions of times greater than those of which I have spoken. We can conceive of no boundary; for even if that celestial vault of crystal existed which the ancients supposed, our imaginations could pierce through it to the other side, and then in thought we could start afresh, and on and on indefinitely. And seeing that space seems to us to be infinite, what wonder is it if the stars should lie at the distances I have named, or at distances millions of times greater still? Indeed, I would rather say that we have good reason to feel thankful that so many of the stars have come so near to us as to allow of their being glimpsed by our eyes, or caught on our photographic plates. There is ample room to permit of their retreat so far into space that the heavens would have append an absolute void, instead of presenting that glorious spectacle which now makes our nightly skies an abounding delight.—*Condensed from Article by Sir Robert Ball, in the N. Y. Sun.*

HIGH ALTITUDES.

The following account of the ascension of Dr. Berson in the balloon Phœnix, gives a vivid idea of the conditions prevailing at lofty altitudes.

The air in general was foggy, and thick flocks of small clouds hid the earth now and then. At first the temperature rose. At a height of 4,920 ft. it was more than 41° F. above zero. Dr. Berson made double notes of the readings of the instruments, cast a glance at the balloon and its ropes, looked down at the earth, and threw out two sacks of ballast. An hour after the start he had risen higher than 16,400 ft., and the temperature sunk to 2° below zero, and the air became dry. The sun's rays were weak. When a height of 13,776 ft. was reached the aeronaut felt the first slight increase of his heart's action after lifting the heavy sandbags. At 11:49 A. M., one hour and 21 minutes after starting, he reached the height of 19,680 ft., and the temperature sank to 17.9° below zero. He felt a slight palpitation of the heart and slight general discomfort, but was otherwise well. At 12 o'clock, one hour and a half after the start, he began, at a height of 22,140 ft. and a temperature of 20° below zero, to breathe artificial oxygen from the bags he had with him, and with excellent effect. At 12:25 the bold aeronaut had outpassed 27,320 ft., at a temperature of 28° below zero. He was now higher than he had been in the preceding May, when his highest point had been 25,910 ft., and this time he felt much better than then.

He now never dared to cease breathing the bags of oxygen except for a few seconds at a time, and during those brief pauses he felt dizzy and dangerously weak. But while continuing the artificial breathing he constantly and with relative ease fulfilled all necessary work. Only once did his eyes close in spite of himself, but the next moment he roused himself, scolding at his own negligence; his voice in the rarified air sounded strangely muffled.

When at the height of 25,584 ft. he had already risen higher than Glashier when the latter aeronaut took his last note of the temperature. At the height of 26,896 ft. Dr. Berson thought of the two French scientists who had died at that height. At about 27,880 ft. Berson reached the greatest height arrived at by Glashier on Sept. 5, 1862, when the latter fainted away, only to awake after his companions had stopped the balloon from rising any higher. But Dr. Berson, after momentary examination of his own strength and his provision of ballast, ventured to rise higher. The temperature had already sunk to 43° F below zero. At the height of 29,520 ft. his balloon passed through and above the thin stratum of high cirrus clouds which he had noticed high in the sky at his start. The veil-like stratum consisted not of ice crystals, but of well formed small snowflakes. At 12:45 P. M., two and a half hours after the start, the barometer indicated only 9.08 inches which corresponds with a sea height of 29,520 ft. and a true height of 30,012 ft. The thermometer stood at 56° below zero. The balloon now stopped. There were only six large and one small sack of ballast left, which were necessary for descending and landing. The balloon stood above the thin snow clouds in a clear sky which stretched faintly blue above. Dr. Berson felt so well that he could certainly have risen another 3,280 ft. But he could not have done so without risking the whole of his successful journey. At this immense height—30,012 ft.—he felt much better than a short time before. Dr. Berson opened the gas valve now and then, and the Phœnix gradually descended, till at the height of 24,600 ft. it stopped, and again began to rise. Another pull at the valve caused it to redescend. At the height of 27,880 ft. it sailed over a river with mighty curves. It was the Elbe at the part, as was afterward found, near Domitz.

But now the terrible cold began to have effect. Dr. Berson, clothed as he was in thick furs, began to shake in every limb so violently that sometimes he was obliged to hold on to the rim of the basket. In slow, waving motion the balloon sank and sank, and during the whole descent only one sack of ballast was thrown out, at the height of 11,480 ft. to moderate the rapidity. Meanwhile a close stratum of heavy clouds had hidden the earth and prevented any ascertaining of the balloon's position. The slow descent, however, allowed of another set of observations being taken, and now the highest temperature, about 42° above zero, was found at the height of 4,592 ft. Thence down to the earth it sank again nine degrees. A whole hour after Herr Berson had been at the greatest height of his trip two of his fingers were frozen, but he brought them to life again by energetic friction. In the enormous cold the barograph had stopped for a while. In the afternoon at 3 o'clock the northern skies showed unmistakable signs of "water," and Dr. Berson decided that he must descend more rapidly. After a few more gentle ups and downs he could distinguish the noise and steam whistles of some large town. When 820 ft. high there appeared at last below him the gray earth, covered by a cloudy sky. Now with the drag strap the balloon passed over a lake, and presently landed, with the help of some countrymen who came up at 3:45 P. M., on a stubblefield at Schonwohld, in the west of Kiel, on the very evening when the German Emperor, the founder of the Phœnix, happened to be staying in that city.—*From the Journal of Aeronautics and Atmospheric Physics.*

ART OF KEEPING COOL.

The comfort of the individual during dog days and those equally oppressive periods which precede dog days, depends not so much upon the position of the mercury in the thermometer as upon the state of mind and body of the person. The reason why Thomas Jones works with more or less vigor at cleaning the streets while John Smith is prostrated beside him is to be found in the difference between John and Thomas, and not in the climatic differences of the two places. The reason why Clara Vere de Vere is cool while her neighbor Fanny Flutter, is very hot is to be found in Clara's superior philosophy.

The woman who worries about the heat, who nervously consults the thermometer every hour, who reads the weather reports with feverish avidity and declares violently that she cannot endure the heat, is acting in a way to make her prophecy come true. Over-activity, mental as well as physical, must be avoided by the seeker after an even temperature. The first requisite of comfort in hot weather is a calm and philosophic mind, which refuses to agitate itself over the vagaries of the thermometer.

Next in importance to one's mental condition comes her physical. Weakness is an ally of heat, and renders the work of the sun effective. It, therefore, behooves the woman who would keep cool to keep strong. She should avoid the feminine pitfall of not lunching or of lunching on odds and ends. She must court strength-giving sleep as she does not need to in the winter. She must stifle her natural impulse to spend a large part of the day in the bath tub, for more than one tub bath a day is weakening. The desire for extra cleanliness must be satisfied by sponge baths, which do not impair her strength.

Clothing plays a more or less important part in inducing coolness. Lightness of weight, as well as thinness of texture, is necessary. The clothes worn next her skin should be very light of weight, and absorbent. Over it the lightest, loosest, thinnest underwear should be worn, and finally light, loose outer garments. A loose collar and loose sleeves are more conducive of coolness than mere airiness of fabric. Loose shoes, which should be changed frequently, are among other cooling necessities.

As to food, extreme abstinence is not to be countenanced. Meat and fatty viands are to be eschewed, but plenty of vegetables, fruits, fish and the like should be eaten. Iced drinks and dishes should be partaken of sparingly. They are bad for the digestion and consequently to be avoided. Besides, they are not cooling. Whatever makes the body so warm that the outside air seems cool to it is cooling. The dwellers in the tropics eat curries and other highly flavored food, and they know more about the science of keeping cool than any other people. Hot drinks, which induce perspiration, are the proper warm weather drinks.—*N. Y. World.*

TWO REMARKABLE LONG-DISTANCE POWER TRANSMISSIONS

There are two remarkable long-distance transmissions of power in successful operation in the United States, although neither are electric transmissions, and each differs materially from the other. One is the transmission of oil by pipe-line, from the natural oil fields of New York, Ohio and Pennsylvania, to tide-water, a distance of over 400 miles. The other is the transmission of natural gas, also by pipe-line, from the the Indiana fields to the city of Chicago, a distance of about 120 miles.

The piping of oil, first from the individual oil wells to storage centers, and then from these storage centers to tide-water, has been a process of gradual development for the last thirty years. The individual wells were gradually connected by feed pipes to larger trunk lines, which carry the oil to the storage centres.

There are twelve pumping stations along this line, situated about 35 miles apart. The pumps operate at a pressure of about 1,000 pounds per square inch, and the capacity of the line is about 30,000 barrels a day.

The main pipe-line is divided into divisions and sections, much like a trunk railway system, and has, similarly, its division superintendents and engineers, section foremen, line gangs and line walkers, telegraph stations and daily reports.

The natural gas pipe-line is, perhaps, a more simple example of long distance power transmissions, and bears many striking points of resemblance to transmission by electricity. In the Indiana gas field about 60 wells are in operation, having an average daily capacity of about 5,000,000 cubic feet each. As in the oil fields, so here, the individual wells are connected by feed pipes to a supply line, which collects the gas and carries it to a pumping station. There large compressors, capable of producing and sustaining a pressure of 2,000 pounds per square inch, force the gas into the transmisson line to Chicago. The normal pressure carried on this line is 300 pounds per square inch, which admits of a daily delivery of from 10,000,000 to 12,000,000 cubic feet of gas to Chicago, where it is sold at a price much below that of ordinary illuminating gas.—*S. Dana Greene, in the Niagara Power Number of Cassier's Magazine.*

CATALINA'S PIGEON POST.

So far as I can learn, the only regular pigeon post service on this side of the continent or the other is that which bears messages every day in the summer season between Los Angeles and the little town of Avalon, on Catalina Island, and bears them at a speed which can be beaten only by the telegraph or telephone.

The steamer runs once a day between island and mainland, and once it has cast loose from the wharf, the island, with a summer population of perhaps several thousands, is as completely cut off from the world as though it were in mid-ocean, and yet the shore is a scant twenty miles away. The demand for some additional service grew. Often there were men of affairs among the visitors, and they were not infrequently sore distressed to find means of communication. I remember hearing one financier declare: "I'd give $500 gladly to get a despatch to Los Angeles; it would be worth $5,000 to me easy."

It remained for two young men of Los Angeles, Otto and Oswald Zahn, to relieve the island visitors and residents from their embarrassing isolation. This was accomplished by the establishment of a carrier-pigeon post between Avalon and Los Angeles. The service was inaugurated last summer and conducted for several weeks with unequivocal success. It was feared at first that the pigeons, which are distinctly "land birds," might hesitate to fly across so large a body of water; but, as far as known, there need have been no cause for anxiety on this point. The message bearers usually started without delay, arriving at their destination with a certainty and promptness almost incredible. The air-line distance from Avalon to Los Angeles is about fifty miles. This was accomplished by some of the Catalina flyers in fifty minutes. From three to four hours is required to make the trip by railroad and steamer.

Last year a considerable revenue was earned in the forwarding of despatches from Catalina by the winged messengers. Small bills posted conspicuously about the town of Avalon convey the somewhat startling information to the non resident islander that "private messages and business orders may be forwarded at any hour of the day, and, in connection with the telephone, telegraph, and cable lines, to any part of the world."

The young pigeon fanciers also add to their income by supplying the daily press of Los Angeles with the latest news from Catalina.

Last year the Zahns had not more than a dozen homers in the service, and it was found by repeated flyings at short intervals that the birds toward the end of the season became less reliable. It is not the flight across the water that exhausts them, but the boxing and shipping on the return trip. The Zahn lofts at Avalon and Los Angeles number this year nearly 100 birds of high degree, and these will insure constant and efficient service to and from the island thoughout the summer.

In a very few instances the birds have been wounded by pot-hunters or thoughtless sportsmen.—*From the San Francisco Chronicle.*

WHY WE ARE HEALTHY.

We are constantly told by those who have discovered that the origin of at least some diseases lies within the boundaries of the germ theory, that we are in constant danger from attacks of these disorders. There is hardly one of us, we are assured, but could furnish from the lining membrane of his own mouth and nose sufficient germs to create a fair-sized epidemic of diphtheria or pneumonia.

Indeed, so generally diffused are such germs, that it might seem almost hopeless to contend with them except by transforming oneself into a walking repository for antiseptics of all kinds.

Theses statements no doubt sound alarming, yet we need not be greatly disturbed by them, although they are in every respect true. By recent investigations, the whole theory of the development and growth of germ diseases may be said to have been changed.

Not only that, but the theory that in their treatment it is necessary to introduce into the system some agent directly antagonistic to the germ in question, has been entirely superseded by the later one, that the normally healthy blood is itself one of the best known destroyers of all classes of germs.

In this fact is contained the answer to those who ask how it is possible to escape the infection with such opportunities for it all about us. The blood of all animals contains a substance which is as deadly a poison to the disease germ as strychnine is to a human being.

The substance is not always present in animals to the same extent; or, rather,—and this is perhaps the better way of expressing it,—the substance does not evince the same power of antagonism toward the same diseases in different animals. In this way is explained the ability of some animals to take a disease with which it is impossible to inoculate a human being, and *vice versa*. The horse can stand an amount of diphtheria poison which would probably prove fatal to a man.

More important still, is the fact that this substance is manufactured by the blood itself, and varies in amount and power in direct proportion to the quantity and richness of the blood.

As we know, the blood is susceptible to many changes. It is when the vitality has been lowered from any cause, that the germs which are lurking about us get a foothold, and begin their deadly work. The lesson is obvious. To secure ourselves against infection, we must keep in good condition.—*Youths' Companion.*

SEA BATHING.

Sea bathing gives more pleasure, and for many is more promotive of health than almost any other form of bathing. As July and August are the months when it is most practiced, a few suggestions may be useful. Those who are in the prime of life and have good constitutions may indulge in sea bathing freely and to advantage. Those who have much adipose tissue, and generate abundant heat, endure a long continued bath, if the water is warm, with profit. We have known such to remain in the bath one or two hours daily for weeks and grow stronger every day. Those who are thin in flesh and generate less heat must not remain in so long. The length of time, however, should be determined by the temperature of the water and the vigor of the person. Experience is generally a good guide. Old people and very young ones must not remain in the water very long, but they may wade along the beach and lie on the warm sand as long as they like, if they are careful not to get cold. Very delicate persons of either sex must be guided by experience; and for such, as a rule, a short bath of ten or fifteen minutes is better than a long one. They may, however, remain on the beach longer, often for an hour or two. There are many who cannot take the sea bath at all. Let these go barefooted on the beach in bathing costume, wet their feet, play in the sand and be like children, when it is warm enough.

In some places there is still sea bathing, that is, there are no ocean waves and swells. This is most suitable for weakly persons and those not skilled in swimming or meeting the waves and swells as they come up on the shore, but for the strong, these waves dashing in on the body produce more powerful reactions on the nervous system and on the movement of the blood, and accelerate the metabolic changes which go on in the tissues. A little skill enables one to enjoy the rougher sea bathing very greatly. It is one of the finest forms of exercise known, but it tires one sooner than still water bathing.

The effects of sea bathing are generally exhilarating both to body and mind. One leaves his depression and low spirits in the briny water, and feels as if his physical sins had all been washed away. The appetite increases and digestion improves. The skin becomes tougher, often rougher, in which case an oiling is beneficial. The scalp and the hair on the head become more vigorous and the step more elastic.

It is better, generally, after the bath, to take a fresh water shower to wash off the salt that might other wise remain on the skin and, when dry, irritate it.

After dressing, a sun bath is generally very agreeable and profitable, or a gentle walk in the sunshine. A half hour or more should elapse before eating.

Those who cannot have the advantage of sea bathing may get nearly or quite the same good by fresh water baths in lake or river. Much of the benefit comes from being out of doors, lightly clad, and from throwing off care and becoming like a child once more.

LIGHTNING.

In this season of thunder storms it will be a welcome consolation to most people to be assured that they are in many respects unnecessarily alarmed by lightning. Human fears are always intermixed with many superstitions, and Forecaster Alexander McAdie of the United States Weather Bureau, exposes a number of these fallacious beliefs in the popular dread of the flashing bolt. Many of the high potential oscillatory currents which dart from the thundering clouds are not of such intensity as mortals imagine; and even should a person be struck to the earth, it would be a serious mistake for bystanders to take death for granted. There is ample reason for the belief that lightning often brings about suspended animation instead of somatic death, and in every case—no matter howsoever apparently hopeless—energetic measures of stimulation and resuscitation should be instantly undertaken, and continued unceasingly for at least one hour. The mechanical expansion and compression of the chest should be performed.

Housewives should not, during a thunderstorm, hide their scissors, thimbles and small articles of steel, as these trifling things will not attract the lightning. It is also idle to seek insulation in a feather bed. On the other hand, terrified wayfarers should not seek refuge under trees, in the doorways of barns, close to cattle or near chimneys. If shelter be sought under a tree as the only comfortable spot, an ash, beech, birch or maple should be selected, as these species are very rarely struck. The oak is frequently hit, and so are the elm and the chestnut.

Lightning rods should be erected upon houses, especially in the country. It is an error to believe that rods are an added peril. The record of lightning bolts for the decade from 1883 to 1893 shows that 2,769 barns, 129 churches, and 831 dwellings were struck. Churches are a particular favorite. There are about 600 fires caused yearly in the United States by lightning. When lightning rods are erected, the conductors should be surrounded by points. Any disastrous discharge of the imprisoned current is thus prevented, and the bolt is forced to the earth.—*Philadelphia Record.*

STRUCK BY A WATERSPOUT.

The bark Wandering Jew left Philadelphia on Saturday, June 1, and went out of the Delaware Capes the same night under a full pressure of canvas, carrying her through the water at a good eight knots an hour. The next day the wind died out and light airs and calms prevailed until the night of the 9th, the vessel's position then being seventy miles east southeast from Cape Hatteras. At midnight the wind freshened and sail was shortened. The vessel was diving in a "nasty" sea, and as morning wore on Capt. Little considered it advisable to take in some more sail. This was about 2:30 A. M., and all hands were sent aloft to take in the upper sails.

While thus engaged Capt. Little and the mate, who were pacing the poop deck, observed through the gloom what appeared to them to be a large white cloud. Suddenly the wind died and this huge white object drew nearer rapidly, when it was seen at its true light. It was a mammoth waterspout, making directly for the vessel's side. All hands had now seen it and realizing their danger, became panic-stricken; but before they had time to move it was upon the vessel, and none remembers further until awakening from a sort of a dream and finding their vessel a helpless wreck and all hands, sailors and officers, badly bruised and crippled.

They had the closest call of any crew that was ever spared to relate the thrilling tale of being struck by a waterspout. The vessel's foremast and maintopmast, with the sails and rigging attached, were wrenched out by the immense spiral of water which came down upon them. For fully thirty seconds the vessel was completely engulfed, and when it passed over her she lay helpless, and all hands that were on deck lay in the scuppers and beneath the top-gallant forecastle, where they had been washed by the great volume of water. It was an experience that no other living sailors have passed through, and the old barkentine, as she lies swinging to her port anchor off Knighn's Point, was the object of curiosity to all passing up and down the river yesterday.

Such frequent appearances of waterspouts in the locality of Hatteras is unusual, and the Wandering Jew is the second vessel to have met them in a few days. The British steamship Ferdnene, narrowly escaped being struck by one of these huge spirals of water.—*Philadelphia Press.*

IN A ROTHSCHILD STRONG BOX.

"The largest shipment of United States bonds to Europe, so far as I can remember," said Mr. J. K. Upton, former Assistant Secretary of the Treasury, "was made in 1875, and consisted of 20,000,000 coupon 4s. It was made under my charge, and I presume my experience was about the same as that of others serving in like capacity. The bonds were in five steel boxes, weighing when packed about four hundred pounds each, all fastened by combination locks, of which we had no key.

"We rode with the boxes to New York in a postal car. At Jersey City station we were met by the superintendent of the Sub-Treasury of New York, who had had secured for us the necessary transportation to the boat, where the bonds were deposited in the specie vault, under the immediate control of the purser, but until the boat left the pier some one of our party kept an eye on the boxes. Once at sea, however, we relaxed our vigilance, and renewed it only when again approaching land. At Liverpool, where we arrived after a pleasant passage, I had some trouble in getting the boxes through the Custom House, not being able to declare under oath that I personally knew their contents, and their being no way to open them. A compromise was finally effected by my taking with me a customs official, who should see that the boxes reached the consignees undisturbed, and when opened contained the bonds as alleged, his expenses to be paid by the syndicate. This delay caused us to remain all night in Liverpool. We had the boxes taken to our rooms, and there we took turns in watching them through the night. The English official, however, had no relief from his vigils. In the morning, through a little British gold, I obtained the practical control of a passenger car, in which we put our personal baggage and the five boxes, for which we paid as extra-weight baggage. The exclusive use of the car was deemed important, the bonds representing such an enormous amount of wealth.

"At London we were met by other Treasury officials temporarily employed at the headquarters of the syndicate, Messrs. Rothschild & Sons, in scheduling and counting bonds and coupons received in payment of the new bonds. We went with our boxes to the office of the firm mentioned, and in its money vaults our bonds were counted, found correct, and a receipt given showing that our duty had been performed, much to my relief.

"This money vault, as I remember it, opened only at the top, through the floor of the room above, and we descended by a little 'lift.' It was not an imposing sight, but it contained an enormous amount of securities issued by nearly every nation in Europe. Two men were employed there all the time receiving and sending out securities or in cutting off the coupons."—*From the Washington Evening Star.*

PURE WATER.

In determining the suitability of water for drinking purposes it is necessary, for practical purposes, to ascertain not what are its true constituents, but whether it contains an excess of animal matter.

Of course this rule applies only to the "soft" waters in general use, and not to the "mineral" waters, which form a class by themselves. All "soft" waters, unless they have been distilled, contain more or less of the lower forms of animal or vegetable life. It is the presence of these that gives the water its peculiar taste, just as the peculiar taste of the so-called mineral waters is due to the presence of different minerals, like iron and sulphur, in solution.

These low forms of life are in themselves of no particular detriment to the water, as long as they remain healthy or are unmixed with germs of disease. But if the water is allowed to stand, or is contaminated by foreign substances, it immediately assumes a dangerous aspect, owing to these same low forms of matter. The greater their number, the more dangerous does the water finally become.

There are two general methods in vogue for the purifying of water known to be more or less polluted.

The first of these, filtration, is employed usually where there are immense quantities to be handled, as in the case of water-supply of a city. It can be made as thorough as is desired by simply repeating the process, or by passing the water through finer material; and is generally sufficiently effective.

In the household, however, this process is not so practicable, partly for the lack of proper means, but more especially because, the subject not being understood, the end in veiw is defeated by the very measures taken to secure it.

We have all noticed the little bags of muslin which are often tied around the end of faucets, and most of us have probably wondered what advantage was to be gained from their use. All faucet-filters are necessarily imperfect in their operation. It is possible, however; by boiling the water, to destroy all source of danger from any form of animal life which may be present.

By this method, to be sure, many of the minerals which are of use will be separated out, but they will again be taken up if the water is allowed to cool in the same utensil in which it has been heated. The water should never be boiled for any great length of time, and should be kept covered while it is cooling.—*Youth's Companion.*

THE PROPER USE OF A SHOT-GUN.

A good sportsman is familiar with his piece, and brave enough to be afraid of it. From the time he takes it out of the case the muzzle of the barrels is on his mind until he has taken it to pieces, cleaned it, and put it away in his case. When he starts out in the morning, he takes out the barrels, and pointing them towards the earth as he holds them in his left hand, he springs the stock into its place with his right. Then having fixed on the little piece of wood which clinches the two parts together, he passes his right arm around the barrels, so that as he carries it the stock points up and behind him at an angle of about forty-five degrees, and the barrels point down toward the earth at a similar angle in front of him. Around his waist or in his pockets he carries cartridges. No charge goes into his gun until he has not only left the house but actually arrived on the grounds where he expects to find game. If he has to drive to the proper woods or the shooting-stands or blinds, he places the piece in the bottom of the wagon, pointing out towards the rear, never once allowing it to point towards himself or any one else who may be standing by. If he is near enough to the woods or shore to walk he carries the gun as described, unloaded, until he reaches the proper place. When climbing over fences, whether with cartridges in place or not, he places the gun under the fence flat on the ground, climbs over or under, and then picks it up from the other side. Resting a shooting-piece against a fence or wall in an up-right position shows the greenhorn or the careless and therefore poor sportsman. —*From Harper's Round Table.*

PERSONALITY.

"Business is business," says the man vowed to that life, and so it is unquestionably, but equally personality is personality. Leaving the latter out of consideration will throw business calculations about as far astray as those of the astronomer who does not allow for personal equations. This the successful man of affairs fully understands.

When it can be recognized there is nothing more interesting than watching the actual consultation of a business man with the promptings of his own soul's equations. Such power of consultation is not possessed by all, and is invisible with many of those who have it.

I remember hearing a young business man describe such a rare revelation in an interview with an older business friend known as the keenest financier. The proposition which the young man had to present was reasonable, seemingly sure of success, and he himself believed in it enthusiastically.

"I laid it before the old fellow," he said "one by one meeting and explaining the vexed points he raised. He ceased questioning me finally because the patent value of the proposition seemed proved as far as words go. He nodded affirmation as each heading was checked off. I felt emboldened to ask, 'What do you think of it, sir?' And then I saw a curious sight. The old fellow sat motionless, looking away into space, his blue eyes growing innocent and far away as a child's who is listening for a distant and familiar voice. I could have sworn he heard something which I did not. Finally he turned to me with a smile and shook his head. 'I can't exactly believe in your plan,' he said. I sat staring at him. I knew, and he knew, that his reason was convinced: it was an instinct alone that held the old man back—an instinct in which he superstitiously trusted and on which he obstinately acted. It was the most extraordinary thing I ever saw. The more so, that events have proved the warning voice gave him a private information which was more than correct. The plan failed dismally, as I too well know."

Extraordinary or not, those who come in contact with successful business men will see the same phenomenon repeated over and over in greater or less degree. Call it a genius for affairs, or what you will, this curious power of divination remains still as unexplained a mystery as any other kind of second-sight.—*From Harper's Bazaar.*

A FEW NOTES ABOUT COIN.

The rei of Brazil, like the mill of our own money table, is an imaginary coin, no piece of that denomination being coined. Ten thousand reis equal $5.45.

Vermont was the first State to issue a coinage on its own authority. Copper coins were issued in 1785.

The first woman's face represented on a coin was that of Pulchera, the Empress of the Eastern Empire.

The Chinese stamp bars or ingots of gold or silver with their weight and fineness, and pass them from hand to hand as coin.

The first Maryland coins were minted in 1662, and were put in circulation by act of Council ordering every house-holder to bring in sixty pounds of tobacco and receive ten shillings of the new money in exchange for it.

In 1634 the Massachusetts General Assembly made bullets a legal tender by the following enactment: "It is likewise ordered that muskett bulletts of a full boare shall pass currently for a farthing apiece. Provided that noe man be compelled to take above XIId att a tyme in them."—*From Harper's Round Table.*

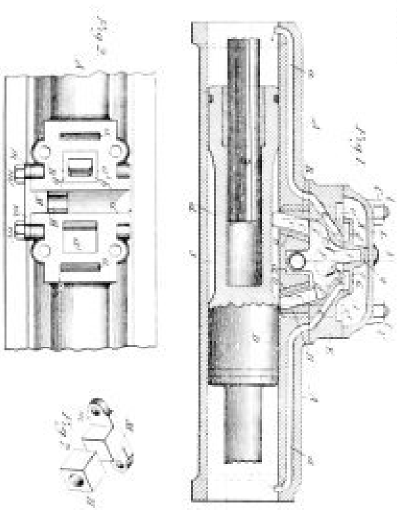
BURROS FIND WATER

The Mexican burros have good horse-sense; they know in a "dry and thirsty land" where to dig for water. A correspondent of the Pittsburg Dispatch describes their close observation of the surface of the ground and subsequent discovery. "We had found in an arroyo a sufficient quantity of water to make coffee, when we observed three burros searching for water. They passed several damp places, examined the ground closely, when the leader halted near us and commenced to paw a hole in the dry, hot sand with his right forefoot. After awhile he used his left forefoot. Having dug a hole something over a foot in depth, he backed out and watched it intently.

To our surprise it soon commenced to fill with water. Then he advanced and took a drink, and stepping aside, invited, I think, the others to take a drink; at all events they promptly did so, and then went away, when we got down and took a drink from their well. This water was cool and refreshing; much better, in fact, than we had found for many a day.

VALVE MOTION FOR ROCK DRILLS.

No. 540,330. Thomas J. Murphy, New York, N. Y. *Patented June 4th*, 1895. Fig. 1 is a sectional view, along the center of the cylinder; Fig. 2 is a partial top view of the valve face; and Fig. 7 shows the bushings in which the valve lever is journaled. The valve *G* is a double *D* valve, working on a flat face. It is moved by means of a rocker *F*, and slide blocks *C*. The rocker is pivoted in bushings *H*, which are confined in the cross groove *a'*, by the port plate *E*, and the caps *M*. The sliding blocks *C* are rounded on their lower ends where they touch the drill piston *D*, and



they slide through removable bushings *B*. The cavity which contains the rocker, is also the exhaust port. The reduction of the diameter of the piston, in order to operate the blocks *C*, is so little that the strength is not sacrificed, and the diameter of the turning bar 3 can be made as large as necessary. The bearing of the block *C* is upon the extreme end of the rocker, at the beginning of the movement of the valve, consequently the valve starts slowly and easily, gradually quickening its motion as it proceeds. The bushings *H* and *B*, and the pins *C* are quickly and easily renewable, without skilled labor.

BOILER FURNACE.

No. 540,718. Robert B. Carsley and John H. Betts, Keyport, N. J. *Patented June 11th*, 1895. Fig. 1 is a sectional top plan of the grate; and Fig. 2 is a sectional side

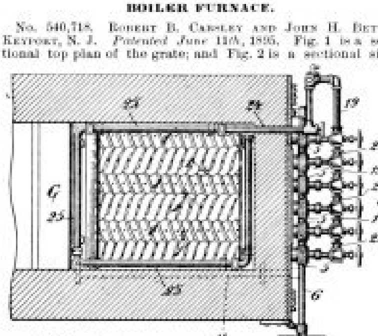


Fig. 1

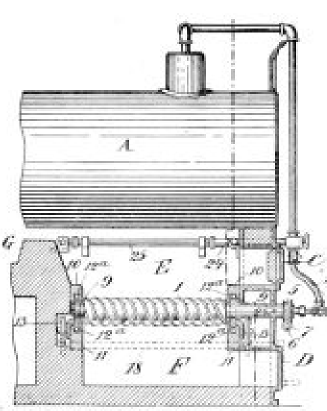
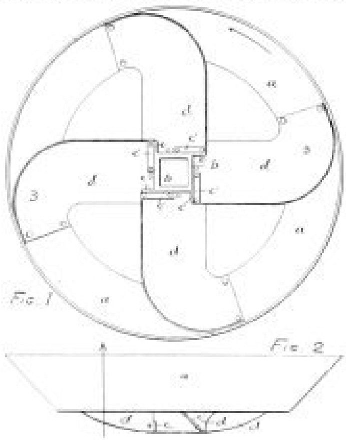


Fig. 2

view of the apparatus in working position. The grate is composed of spiral bars, the spirals being alternately right and left handed. Each bar has four spiral threads, the right hand spirals being concave, and the left hand ones being convex; the convex and concave spirals roll closely one into the other. The bars are hollow, and perforations extend outward from the central bore to the grooves. Each bar rests in suitable trunnions at the ends, and can be rotated by means of worm wheels 5, worms 7, shaft 6 and wheel 8. These are turned at intervals, not continuously. A blast of air is blown into the hollow bore of each bar by means of an independent steam jet as shown in Fig. 1. Combustion is also aided by superheated steam, which is blown in jets from the cross pipe 24 into the upper part of the fire. The steam for this purpose is led through the superheating pipes 25, which are made of hard bronze to endure the intense heat. It is claimed that the jets of air which are distributed all over the area of the grate, make a very strong fire, which in connection with the superheated steam jets, enables soft coal to be burned rapidly without any smoke whatever.

FAN WHEEL.

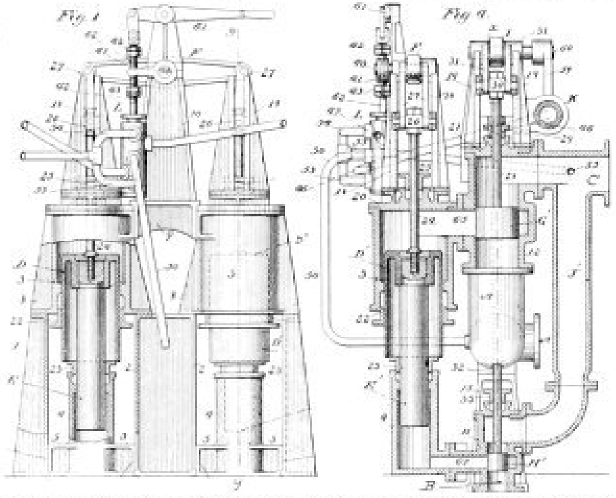
No. 536,998. Darius Bennett, Nelsonville, Ohio. *Patented April 9th*, 1895. Fig. 1 is a side view of the fan wheel; and Fig. 2 is a top view of the same. The rim of the wheel, *a*, is made cone shaped as shown clearly in Fig. 2. The vanes *d*, extend radially from the hub *b*, and are united to the rim by curved elbows 3. They are inclined at an angle



of 45° to the axis of the shaft, and they are so wide that they project beyond the edge of the rim, as in Fig. 2. The air enters at the small end of the cone, and passes through in the direction of the arrow, while the wheel rotates as shown by the arrow in Fig. 1. It is claimed that this wheel is very effective for mine ventilation.

HYDRAULIC PUMPING ENGINE.

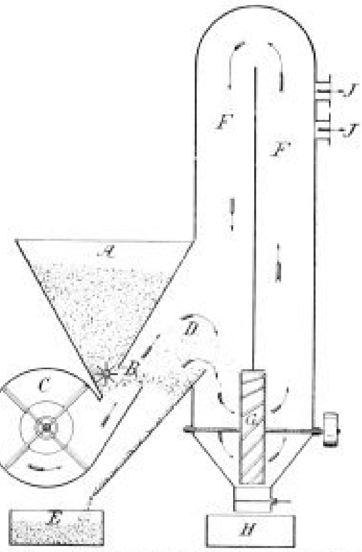
No. 538,880. Ernest W. Naylor, Bound Brook, N. J. *Patented May 7th*, 1895. Fig. 1 is a side elevation, partly in section; and Fig. 4 is a vertical cross section on the line *y y*, of Fig. 1. This machine is designed to pump water against heavy pressure, by means of water of much less pressure and is intended for mining purposes. The water for driving enters at *A*, and passes alternately to the top of the working chambers 3. The plungers *D*, *D'* are connected by rods 24 and links 27, to a beam *F*. Each driving plunger is connected to a smaller forcing plunger *E*, *E'* which forces water into the delivery pipe *B*. The admission of water to the driving plungers *D*, and the escape of water from the forcing plungers *E'*, is controlled by the piston valves *G'* and *H'*, all of which are connected by suitable rods to the beam *I*. These valves are moved simultaneously by means of a motor *K*,



which operates the beam *L*, and moves independently of the plungers *D*. This motor is composed mainly of a double acting plunger which is attached to the arm 59, and is controlled by the valve *L*. This valve is operated by an arm 41, upon the shaft 40 of the main beam *F*, or it can be operated by means of the hand lever 61. The stroke of the main plungers can be regulated by adjusting the nuts 42, 43 upon the rod of valve *L*. The inventor claims that in using an engine of this variety having main plungers of 62 inches diameter, and 72 inches stroke an efficiency of 85 per cent. is attained. The motor *K* is driven by water taken from the driving pipe *A*, through the tube 50. The spent driving water escapes at *C*, and some of it passes down the pipe *J*, forming the supply for the forcing plungers below.

MIXER FOR AIR AND COAL DUST.

No. 540,114. Constanz Schmitz, Berlin, Germany. *Patented May 28th*, 1895. To burn powdered fuel advantageously the proper amount of air must be supplied at all times. Too much air must be avoided as carefully as too little, the former cools and dilutes the gases, while the latter results in imperfect combustion. This apparatus is designed to maintain at all times a proper proportion between the coal dust and the air necessary to burn it effectively. From a funnel *A*, the ground coal is led by means of a feeding roller *B*, into an air current produced by a fan *C*, or by any other suitable means. This air current carries the coal through a channel *D*, into the store-room *F*. The air current, with which it moves, allows all the parts heavier than the fine coal dust to



fall down. These parts, say coarser coal pieces, mineral admixtures and the like, are collected in a vessel *E*. In the store-room *F*, the the air is put in motion by means of a fan *G*. The velocity of the air is such that it maintains in suspension exactly such a quantity of coal dust as, under the conditions obtaining, can be burned in the most advantageous manner. When a larger quantity of coal dust is introduced than the air in motion is capable of maintaining in suspension, it falls down and is collected on the bottom of the store-room, whence from time to time it is discharged into a vessel *H*, placed underneath the store-room *F*. From the store-room the mixture of coal dust and air is carried off through one or more conduit pipes *J*, to the furnaces, where it is consumed.

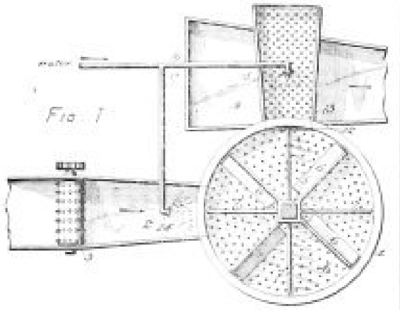
SPOONING TOOL.

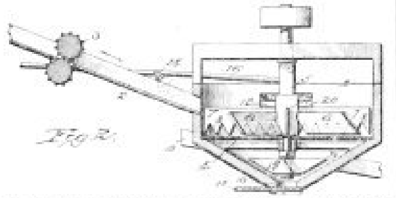
No. 540,201. Nathan E. Varney, Denver, Colo. *Patented May 28th*, 1895. The end *B* is an ordinary drill spoon, attached to the same handle with the improved spoon *D*. This is made of a conical coil of steel wire, which projects three or four inches beyond the end of the handle. The point of the coil is made flat, and is split to make two teeth. The inner edges of these teeth are made rugged, so that they will take a good hold of the rags, paper, etc., which is used for tamping shots. The tool is very useful for removing charges that have missed fire, the toothed end being well adapted to

seize and fasten to the paper covering of giant powder cartridges, enabling them to be removed from the hole with safety. It is also very useful for bringing up the fragments which are broken off from over tempered drills, etc., which must be removed before the drilling can be resumed.

COAL WASHER.

No. 541,324. George E. Giles, Carbondale, Pa. *Patented June 18th*, 1895. Fig. 1 is a top plan of the machine; and Fig. 2 is a vertical section of the same. The coal is passed through crushing rolls 3, which reduce any lumps that may be amongst it, and thence through the chute 2, to the tank 1. The tank is divided into two chambers by a perfo rated plate or grating 4, and is filled with water to the sill of the delivery spout 12. The coal is swept over the grating 4, by a set of rotating paddles 6 and 7, which are alternately inclined and vertical as shown. The clean coal escapes from the tank through the door 12, and the dirt passes downward

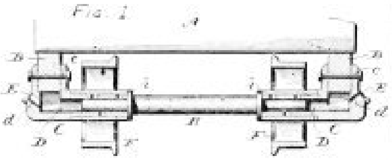




through the grating into the lower chamber. A small propeller wheel 19 stirs the sediment and keep it from lodging, so that when the slide 11 is opened, it will run out freely with the water. The coal passes down the perforated chute 13, under the sprinkler 15, to a rotary screen of ordinary construction.

MINE CAR JOURNAL.

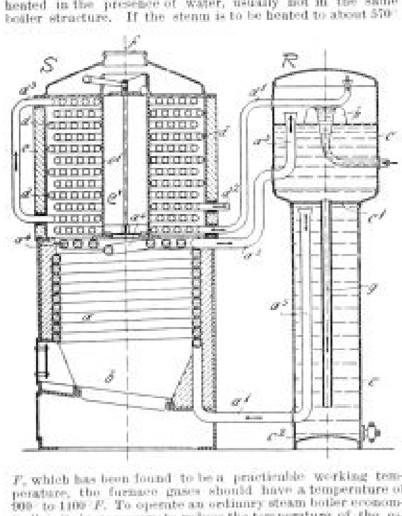
No. 537,131. JOSEPH STEPHENS, FOREST CITY, PENN'A. *Patented April 9th*, 1895. Fig. 1 is a section through a pair of wheels and journal bearings; Fig. 3 is a detail view of the bearing. Each bearing consists of a hollow cast-iron sleeve which is provided with suitable flanges by which it can be bolted to the car frame. The projecting part of the sleeve



is turned to fit the bore of the wheel *F*, and is bored to fit the dummy axle *H*. This axle serves only as a brace to maintain the bearings in proper alignment, and does not receive the wheels. Therefore it never wears out. The interior part of the casting is used as an oil box, being provided with oil holes *K*, and a filling hole *d*, and cover *E*.

SUPERHEATING BOILER.

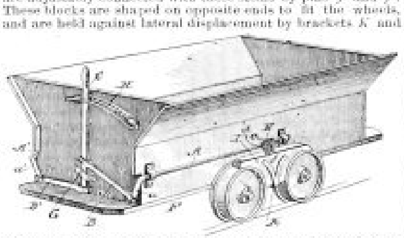
No. 539,827. WILHELM SCHMIDT, WILHEMSHOHE, GERMANY. *Patented May 28th*, 1895. It has been found by extensive experiments that the use of superheated steam is attended with considerable economy. But steam cannot be superheated in the presence of water, usually not in the same boiler structure. If the steam is to be heated to about 570°



F, which has been found to be a practicable working temperature, the furnace gases should have a temperature of 900° to 1100° *F*. To operate an ordinary steam boiler economically, it is necessary to reduce the temperature of the escaping gases to about 480° *F*. It has also been found that more than half of the steam generated in a locomotive boiler is generated from the fire box sheets alone, and that the remainder of the heating surface, although exceeding the fire box surface in extent many times; is far less efficient because of the lower temperature of the gases passing over them. All of these facts have been duly considered in designing the boiler here shown. Steam is generated only in the coils *a*, which constitute the fire box. The circulation is very rapid, and the mingled steam and water is delivered through the pipes a^2 and a', into the top of the receiver *R*. Here the steam parts from the entrained water, and passes through the pipe d' to the coils *d*, in the superheating chamber *S*. The steam passes through alternate coils until it reaches the top of the chamber, then downwards through the intermediate coils, and out through the pipe d^2. The hot gases fill the upper chamber, and escape through the central flue *e'*, being controlled by the dampers shown. The head of water in the receiver is sufficient to keep the coils *a* always full, and the coils being intensely hot, the steam is generated under the most economical conditions. The heat remaining in the hot gases after they pass above the coils a^4, is extracted by the superheating coils *d*, and the temperature of the escaping gases is made as low as desired. Thus the receiver serves, not only to catch and deposit the impurities of the feed water which enters and overflows at *h*, but to separate the steam generating from the superheating chamber, and to free the steam from the entrained water which usually makes superheating impracticable.

BRAKE FOR MINE CAR.

No. 540,248. SCOTT HAIRE, REDSTONE, PA. *Patented June 4th*, 1895. The shafts *A* and *A'* on each side of he car *F*, are journaled in suitable bearings and have arms *d* and *d'* and cranks *a* and *a'* respectively. The operating lever *C* is pivoted to the front of the car at *G*, and is connected with the cranks *a* and *a'* by the links *B* and *B'*, which are connected to said lever on opposite sides of and equi-distant from pivot *G*. The upper end of lever *C* passes through notched keeper *H*, by which it is held in position. The brake blocks *I* and *I'* have vertical stems, *E* and *E'* respectively, which have a series of pin holes *e* and *e'*. The arms from the shafts are adjustably connected with these stems by pins *f* and *f'*. These blocks are shaped on opposite ends to fit the wheels, and are held against lateral displacement by brackets *K* and



K', which are fastened to the bottom of the car and have their outer ends spread, as shown, to obtain a broad hold on the blocks. By operating lever *C*, in the proper direction, the shafts *A* and *A'* will thrust the brake blocks firmly down between the wheels, upon both sides of the car.

COAL DRILL.

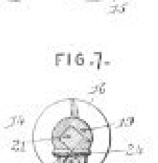
No. 541,171. LEWIS W. LEGRAND, WILKES-BARRE, PA. *Patented June 18th*, 1895. Fig. 4 shows the form of the joint which is used to connect sections of the auger; Fig. 6 shows the drill with the bits in place; Fig. 8 shows the cutting bits; and Fig. 7 is a section across the socket, showing the bits in place. The auger is made with a hollow or tubular body 15,

FIG. 4.

FIG. 6.

FIG. 8.

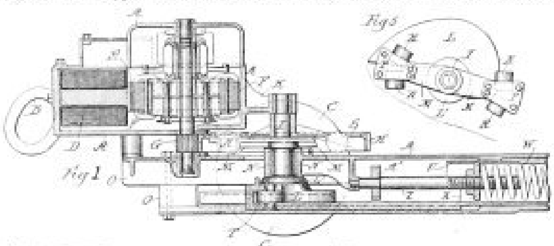
FIG. 7.

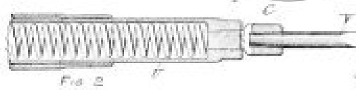


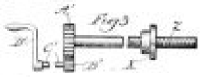
and a spiral blade 16, which may be either double or single, as preferred. Each section is formed with a conical socket 17, having a T slot 18. The end of the feed screw, and of each extra section or lengthening piece, is provided with a round taper shank, which is secured by means of a pin 32, and which has a stud 31. This stud catches in the corners of the T slot 18, and prevents the parts from separating, either when drilling or backing out of the hole. A leading bit 21, is held in a central socket 19, and a smaller enlarging bit 22, is held in a side socket 20. Both bits are notched on their edges so that they may be held in place by the single pin 24. This combination of bits makes a very rapid, free cutting tool.

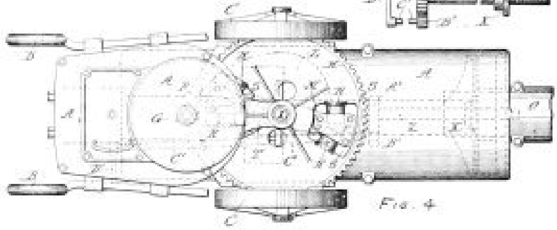
MINING MACHINE.

No. 536,438. EDMUND C. MORGAN, CHICAGO, ILL. *Patented March 26th*, 1895. Fig. 1 is a vertical section of the machine; Fig. 2 shows the pick, and its holder; Fig. 3 shows the means of adjusting the tension of the striking spring; Fig. 4 is a top view of the machine and Fig. 5 shows a top view of the main





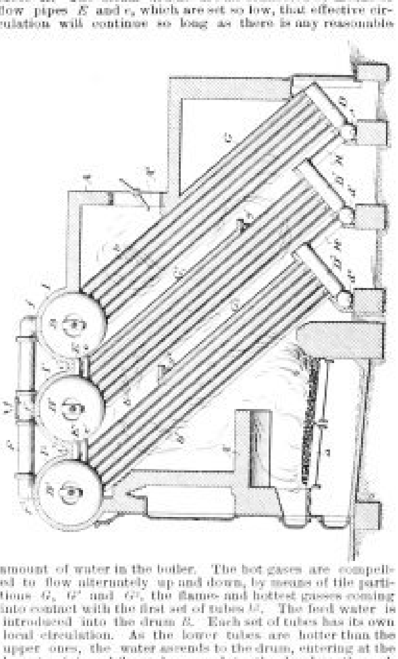




cam. The machine is driven by an electric motor consisting of the magnet *D*, armature *F*, and pinion *G*, which gears into the horizontal gear wheel *H*. The tool *V* is socketed in the end of a hollow plunger *U*, which slides within the guide tube 3. The pick is shot forward by a strong spiral spring *W*, and is drawn back by a large cam *L*, which engages the roller *T*, at the back end of the plunger *U*. The cam is cast in one piece with the spindle *I* and buffer arms *M*. The wheel *H* is loose upon *I*, and has large pockets *S*, in which the buffers *P* and *R* have some play, thus the connection between the motor and cam is made elastic. The rubber blocks *R* absorb the most of the shocks. The spring *W* bears against the circular nut *X*, and the tension may be adjusted while running by rotating the screw *Z*. This may be done turning the handle *D'*, and pinion *B'*, which are shown in Fig. 3 and 4 by dotted lines. The machine is mounted upon two wheels *C*, and steered by two handles *B*, in the usual manner.

WATER TUBE BOILER.

No. 541,330. LAURIE M. MOYES, PHILADELPHIA, PA. *Patented June 18th*, 1895. The water tubes are divided into three groups, *b*, *b'* and b^2, and they are connected to the three steam drums *B*, *B'* and B^2. Each vertical row of pipes is connected to a header *D*, and the headers are connected to the mud drums *d*, *d'* and d^2. The headers are connected at the top, to the next mud drum, by means of the tubes *H*. The steam drums are all connected by means of flow pipes *E* and *e*, which are set so low, that effective circulation will continue so long as there is any reasonable



amount of water in the boiler. The hot gases are compelled to flow alternately up and down, by means of the partitions *G*, *G'* and G^2, the flame and hottest gasses coming into contact with the first set of tubes b^2. The feed water is introduced into the drum *B*. Each set of tubes has its own local circulation. As the lower tubes are hotter than the upper ones, the water ascends to the drum, entering at the lowest point, and flows downward to the headers through the upper tubes. The sections of the boiler being amply connected at both top and bottom, there is no danger that any section may become unduly empty or overheated.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 2. SCRANTON, PA., SEPTEMBER, 1895. WITH WHICH IS COMBINED THE MINING HERALD.

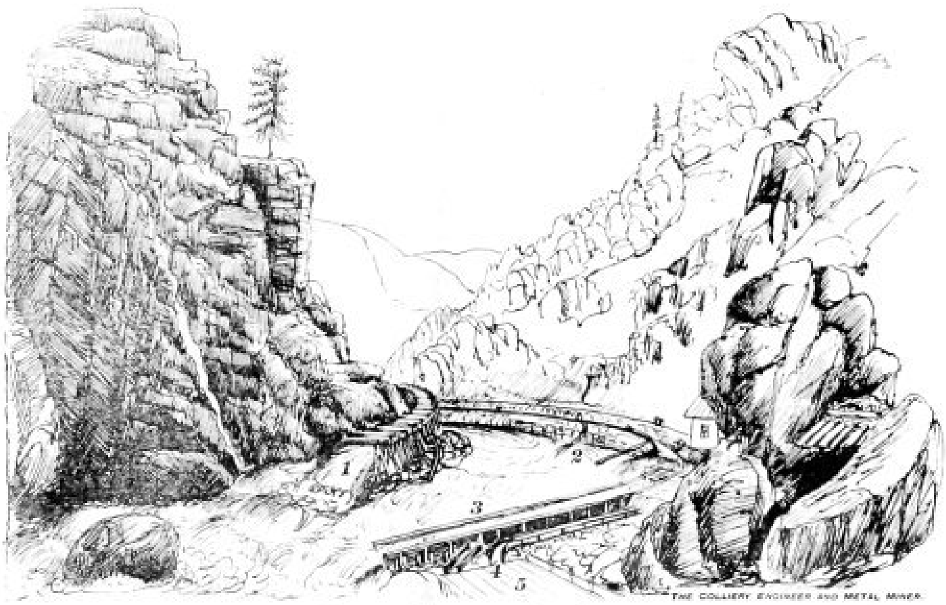
Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING FOR PLACER GOLD.

A NOVEL AND GIGANTIC SCHEME IN CLEAR CREEK CANYON, COLORADO.

Showing how Gold is Obtained on a Large Scale from Gold Bearing Gravels under Favorable Conditions.

"Prospecting" may roughly be defined as looking for precious metal we hope and believe exists, but of whose actual presence, we have no positive assurance. "Mining" on the other hand is when we have actually found ore and are following and developing it. Under this definition there are many kinds of prospecting. There is prospecting for mineral leads with pick and shovel and for placer gold with a gold pan and rocker. There is prospecting on a bigger scale by diamond drills, such as are now puncturing the mountains above Leadville in search of the gold belt. It is prospecting on a gigantic scale when a large company, like one at work at Idaho Springs, drives a tunnel for five miles through the mountains in search of veins of gold, some of which they know to exist, and others they hope to find. It is prospecting still when, as in the present case, a company undertakes to work the gold bearing sands of Clear Creek on a gigantic scale and with gigantic and novel appliances. Instead of the miner's little ditch or sluice, they have constructed a flume a mile or more in length, twelve feet wide and eight feet deep to turn the course of the primeval torrent and carry its waters bodily on one side, so as to expose and lay bare an interval of a mile and more of the river bed for their operations. Instead of the miner's little pipe short tom or long tom and driblet of water, the latest invention, Allen's big stave pipe over three feet in diameter, is brought to bear and has been laid down for a mile, whilst attached to it is another mile of black steel 16 inch pipe forking at the end to accomodate two giant nozzles with a pressure of 125 feet vertical head and a force like that of a cannon. These powerful nozzles are to wash and blow the gravel out of the creek bed and up through an elevator pipe into a double flume above them where, as the gravel washes rapidly over the floor of the sluice, the heavy gold drops to the bottom and is caught in the interstices between square blocks of wood, called riffles, with which part of the floor of the sluice is lined, or failing in this it passes over a perforated iron floor and drops through to a smaller sluice a little below and along side it, lined with brussels carpet to catch the finer and residual gold that may have escaped the riffles and perforations of the larger sluice; finally contributions from both find their way to a wide troughlike sluice called an "undercurrent" lined with hundreds of small riffle bars and with carpet. Here it is treated further and collected with amalgam or quicksilver, which by its peculiar affinity for gold collects it in its silvery body, from which later it is easily extracted by retort. But we are anticipating.



SLUICES AND FLUME AT THE STONE DAM.

1, FLUME; 2, PIPES AND NOZZLES; 3, GOLD SLUICE; 4, SMALL SLUICE FOR FINE GOLD; 5, UNDERCURRENT SLUICE.

CLEAR CREEK CANYON.

Clear Creek Canyon is one of the steepest and grandest canyons in these mountains. It is cut through granitic rocks for a distance of forty miles and to a depth of upwards of a thousand feet from its commencement above Georgetown, to its outlet on the plains at Golden. This was the work of ancient glaciers and of the present stream.

About 13 miles above its outlet, on the foothills, the creek forks, one branch going up towards the gold mining town of Central City, the other to the gold and silver mining town of Idaho Springs, heading above the silver mining town of Georgetown. Thus it drains two gold bearing areas. At Central in addition to what it may bring down in the way of gold from the veins and rocks direct, it brings down also a great deal of fine flour gold, the refuse of the stamp mills who lose on an average upward of 40 per cent. by their crude methods. This refuse gold has been accumulating for the past thirty years from the mills alone, not to say what for ages has been derived from the rocks themselves. The first paying placer was opened where Central and Blackhawk now stand. The bed rock was very rich and miners are said to have averaged $100 or more per day with their rockers and "short toms" as long as their small claims lasted.

CHOICE OF LOCALITY.

We may assume, then, that the gold bearing streams unite with their freight at the forks of the creek, hence, the reason why the originators of the present scheme selected a site for their operations a little below this at a point now called Roscoe. The other reasons why the originators of the scheme and their engineer, after having looked the creek over from end to end, selected the present location above all others, will appear when we describe the locality in question.

As we ascend Clear creek about eight miles, we reach a point where its scenery reaches its grandest, by reason of the precipitious character of the granite walls and the narrowness of the canyon between them.

Tier upon tier of massive layers of granite and gneiss rise above one another, forming steep cliffs, which at this point begin to be intersected by great red dikes and veins of feldspar and quartz, which are suggestive of mineral, the more so as some of them are rusty and oxidized. At Roscoe there are several such veins, some of which, near the surface, are being worked successfully for gold.

THE STONE DAM.

It is by the breaking down of a huge vein of this kind that lay right across the canyon that we enter the grand portal to the Roscoe property. The great vein originally was thrown, like a natural dam, across the creek till, the waters undermining it, it fell through and the stream now dashes down a foaming rapid with a vertical fall of thirty feet between great boulders.

This struck the engineer as an excellent point. Here was a splendid place for a dumping ground of the material dug out above. One of the first things to be looked for in a large placer property is convenience for dumping the excavated gravel, otherwise the property will soon become choked up by its own refuse and have to be abandoned, no matter how much gold may still be there.

Here, then, was both a drop of some thirty feet and a powerful rapid torrent to carry away the debris as fast as it collected.

Passing through this wild and most picturesque gateway, worthy of the brush of a Bierstadt, now known as the "Stone Dam," we come upon a long stretch of upwards of a mile or more of comparatively quietly moving water, underlaid by deep gravel, locally called a "bar," part of fine gravel, part of good sized boulders. As gold is generally found either amongst the large boulders or the fine gravel, this combination of circumstances was further in favor of the choice of the location. As a secondary consideration, there were the gold "leads" we have alluded to, which doubtless contributed some of the coarse gold to the placer. Again, the railroad ran conveniently close to the stream and the projected works on the bank, just about the right height for using its grade for the pipe lines to work the great giant nozzles in the stream bed below. The opposite bank, too, was here low and gentle, and well adapted for constructing the great flume along its margin. And, as if nature herself had foreseen the undertaking, a natural bend and widening outwards of the bank at one point for upwards of a hundred yards contracted the main waters of the stream into a natural mill sluice, which later proved most advantageous for beginning the construction of the flume. But what of all these natural advantages if there is no reasonable assurance of gold along this stretch? This question has been satisfactorily answered.

Placer Mining at Clear Creek.

PROSPECTIVE GOLD IN THE AREA.

The area is an old prospect ground, prospectors have poked about and scratched its surface at times of low water and there are wrecks of old wheels and primitive sluices. These wheel pumps were used to pump water out of the pit from which miners were taking gravel but were never successful in handling water to a depth of more than four or five feet. By them the whole surface has been washed over and still one can make a days wages by washing in some places.

Thirteen prospect holes have been sunk to bed rock which lies at a depth of 20 to 30 feet. The gold grew coarser the nearer bed rock was approached and on bed rock the dirt was very rich. The lowest amount taken from any hole was $26.30 and the highest $87.60. The bed rock averaged from 2 to 4 to 10 dollars per yard. The largest nugget weighed a little over an ounce." The Mining Industry of Denver institutes comparisons between these sands of Clear Creek and those of other parts of the world. New South Wales is accredited with $6.66 per yard; California 10 to 20 dollars; Canada $1.34; Alder Gulch, Idaho, estimated product at bed rock at $10.00 per yard and a total production for six miles of work at $80,000,000. One pan of dirt in Clear Creek is said to have yielded over 15 ounces in gold. The average yield of the paying placer mines of California worked by hydraulics is about 6 cents per yard. Clear Creek has been worked all along its length by prospectors since the days of '59 but on a most superficial small scale. In few cases has the deeplying bed rock, the favorite repository for the richest and coarsest gold, been reached, or even attempted owing to the great depth at which it generally lies, consequently, the present undertaking will be upon practically "virgin" and unexplored ground. The main aim is to reach bed rock and expose and clear it up and even penetrate some depth into it in search of gold that may sink through crevices. This will be done over an area at least a mile long and from 50 to 250 feet wide.

PLAN OF SCHEME.

The *Mining Industry* gives a concise account of the programme of the undertaking illustrating it by a somewhat ideal sketch giving a rough idea of how it may appear in a month or so. The cut (which we reproduce) shows a giant and hydraulic elevator at work in the dry bed of Clear Creek from which the water has been removed to one side of the big flume. The *Industry* says: "A great flume is constructed by the side of the creek capable of carrying all its water, which is turned into it by means of a dam. Then a pit is dug to bed rock at the lower end of the ground to be washed which may require a pump. A gravel lifter consisting of a pipe through which rock, gravel and water is forced by the water jetted from a hydraulic nozzle below it, carries the rock and gravel to the height above the surface necessary to get needed grade, down which it is washed to the canyon below using the needed "under current" sluice to secure the fine gold. A sluice box is meanwhile carried along in the bed rock of the pit. A pipe giving a head of over 100 feet and carrying a thousand inches of water gives the needed hydraulic head. When the working has advanced far enough up the stream, the pit left behind can be used for a dump. The flume by the side of the stream will furnish the power to run a dynamo which will operate a derrick and pump and by large railway "headlight" lanterns the ground will be lighted at night."

As the incipient stages of a big concern like this are amongst the most interesting and instructive part of its history we have given in our illustrations a view of things as they are at present in their incomplete state and when operations are at a standstill, owing to an unusual and protracted flood and very high water. Later we propose to give the details of the work and construction from its inception to its completion which should be within the course of the coming month.

OHIO COAL STATISTICS FOR 1894.

Interesting Figures Compiled From the Report of the Chief Inspector of Mines.

A summary of the report of Chief Inspector of Mines, R. M. Haseltine, of Ohio, shows that in 1894, the production of coal was 11,910,219 tons, a decrease of 2,917,878 tons as compared with the previous year.

By analysing the tables we find that the production of lump coal decreased 2,311,009 tons; nut coal, 373,268 tons; and pea and slack 233,601 tons. Of the total amount of coal produced, 4,371,801 tons, or 36.7%, came from Perry, Athens, and Hocking counties, a district known all over the country as "The Hocking Valley Coal Field." Jackson county produced 1,499,287 tons, the largest production of any single county. This county and the three previously mentioned, are the four leading coal counties of the State.

Of the year's production 2,555,466 tons were mined by machinery. This is a gain of 2,392 tons as compared with 1893, and is the only gain in production found in the report. Machine mining is confined to 9 of the 30 coal producing counties of the State. The largest production occurred in Hocking county which is given as 1,343,188 tons or 52½% of the entire amount of machine mined coal. This is followed by Athens with 22⅐ and Perry with 20⅘%. The three counties of Athens, Hocking and Perry produced 96% of the machine mined coal of the State. 452 hands were employed in operating the machines and 3,207 hands in blasting down and loading the coal after it had been undermined by the machines. Installations of mining machines were made at six mines during the year. There are 36 mines in the State equipped with machines of which 19 are supplied by compressed air and 16 use electricity. Of these 175 machines of various types, 171 were on the active list during the year, an increase of 23 over 1893. Of this number 60 are of the electric type, and 112 compressed air, which is a gain in electric machines of 19 and an increase of 5 in those operated by compressed air.

There were 31,493 persons employed in and about the mines during 1894; of this number 25,163 are classed as miners, a gain of 2,700 as compared with 1893. Seventeen counties showed gains in the number of employes aggregating 3,337, while thirteen counties showed losses aggregating 675. One-third of the gain in number of miners occurred in Hocking county. The reason assigned for this is that only machine mines could be profitably operated under the intense competition which prevailed during the year, and Hocking, being the leading machine mining county in the State, collected the greatest number of miners.

There were 119 new mines opened during the year, 67 remained idle, and 59 were either exhausted or abandoned. At the close of 1894 there were 1,163 mines in the State, of which number 1,096 were in operation a greater or less portion of the year. Of this number 411 employed more than ten men each, and 685 a less number.

257 accidents occurred in and about the mines during the year. Of this number 45 were fatal, 116 serious and 96 of a minor character. There was one accident for each 46,343 tons of coal mined; 264,672 tons were mined to each life lost and 102,674 tons to each serious injury. 38% of the year's casualties were due to falls of roof, 15% to falls of coal, 23% to contact with the mine cars, 7½% to premature explosions of powder and one fatal and four serious were due to fire-damp.

The Iron Ore production was confined to the three counties of Jackson, Lawrence and Scioto in which there were mined 58,043 tons which is the lowest of any year since the department has had cognizance of the industry. The fire clay industry has also suffered keenly from the commercial depression. The production amounted to 942,913 tons, a loss of 89,435 tons over 1893. That it was quite general will be seen when out of 15 counties that reported, 12 returned losses in production. There was a loss of three weeks in the time worked, 75 in the number of miners and 162 in the number of hands employed in the manufacture. In the production of limestone the returns for the year show a loss about proportionate to that which occurred in the other statistical branches of the report. The industry was carried on in 39 counties of the State. The average time worked was 25 weeks, a loss of two as compared to the previous year. The number of men engaged is given at 2,384, a loss of 544, the heaviest that has occurred during the time that the industry has been under the care of the department.

The report contains an article on the quality of oil used for illuminating purposes in the mines, and one on the quantity of powder consumed, and the amount of coal produced to the keg in the several counties. There is an auxiliary article on mine fires, their origin, prevention and extinguishment, and one on electricity in bituminous coal mining which contains many interesting figures obtained by absolute experiment.

Something About Mechanical Rubber Goods.

No single treatise or other work hitherto published on the India rubber industry gives an insight into such a variety of uses of this important material as does the new "Descriptive Catalogue and Price List of the N. Y. Belting & Packing Co., L't'd.," a bound volume of 100 pages. This catalogue is a distinct departure from others, in that it combines the artistic with the practical. The commonplace and somewhat monotonous trade catalogue is enlivened by sketches and descriptions that, in a pleasing way, convey an idea of the various uses of rubber, besides containing much information on the methods of manufacture, in which respect it marks a wide difference from the former policy of manufacturers, of keeping secret all facts of this kind.

This catalogue is introduced with some notes on the history of the N. Y. Belting & Packing Co., L't'd. with illustrations and descriptions of their three factories. Some account of their trade-marks follows, after which comes the department of rubber belting, to which thirteen pages are devoted. There is an account of rubber belting in general, followed by detailed descriptions of the belting made by the company for grain elevator use, threshing machines, paper mills, etc.; price lists of leather and rubber belting, and information of value on the use and care of belts, rules for calculating the speed of pulleys, rules for calculating horse power, how to splice belts, and other similar information.

Twenty-four pages are devoted to rubber hose, with an account of its manufacture; steam hose, which is an important product of this company, occupies three pages, with valuable tables and lists; one page is given to air-brake hose, two to fire hose, four to cotton hose and the "Leatherite" treatment of same; three to suction hose; seventeen to mats and matting, including the company's new patented rubber tiling, which they have supplied to the new steamers St. Louis and St. Paul; eight pages are given to packing, gaskets and tubing, and six to emery wheels. Considerable space is devoted to specialties, of which a large variety are illustrated, together with remarks on vulcanization and mold work. Bicycle tires are briefly disposed of, as a separate pamphlet has been published on this subject. A double index, new and convenient in arrangement, gives the pages of both the lists and descriptions of articles. Altogether it is the most complete, comprehensive and artistic rubber goods catalogue that has ever been issued. The Scranton Supply and Machinery Co. of Scranton, Pa., are special representatives in the Anthracite regions for the N. Y. Belting & Packing Co. They will be pleased to send a copy of this catalogue to any mine manager or superintendent.

Coal and Coke Exhibit at Atlanta.

The Tennessee Coal, Iron and R. R. Co. is preparing an extensive exhibit for the Cotton States' Industrial Exposition. It will consist of full sections of the company's coal seams, specimens of coke, samples of pig iron, iron ores, limestones, etc. The most interesting feature of the exhibit will be a relief map of the Birmingham (Ala.) district showing the contiguity of the company's raw materials to the furnace plant. Photographs of the various plants with maps etc. will also be shown. The exhibit will be in the East Wing of the Alabama building just east of the Government building. It will be in charge of Mr. Chas. E. Bowron, mining engineer, whose name is familiar to most of our readers, owing to his contributions to our columns. He extends a hearty invitation to all our readers, to visit the exhibit.

COAL-WASHING.

NOTES ON A SOUTHERN COAL-WASHING PLANT.

A Description of the Coal Treated and of the Machinery Used With a Statement of the Results and Cost of Operation

(By J. J. Ormsbee, Tracy City, Tenn.)

[Transactions of the American Institute of Mining Engineers.]

Attempts at coal-washing have been made in the Southern States during the last twenty years; but it is only within the last four or five years that the practice has become at all general. It might perhaps be claimed as one of the blessings derived from our departed "booms;" for, during their sway, the supply of coal of all qualities, good and bad, could not equal the demand; but with the subsidence of the inflated demand, came imperative calls for fuels of better quality, and washers, previously regarded as luxuries, became necessities.

Among those now in use in this section are representatives of the following types or classes: the trough washer; the jig washer; the percussive table; and those washers, in which a constant upward current of water effects the separation. Without having full statistics, it is safe to say that there are in successful operation in the South more washers of the last class than of any of the others. The purpose of these notes is to present data with regard to the construction, operation, and results of one of these current-washers, based mainly on the plant at No. 2 Slope, Pratt Mines, Alabama.

The coal is mined from the well-known Pratt seam, having here an average thickness of 3 feet 6 inches. It has distinct cleavage-planes; and breaks in cuboidal lumps; is bright black in color, firm in structure, and air-slacks only after considerable exposure. It burns freely, leaving a gray or buff-colored ash. The lump and nut-coals are used for domestic and steam purposes (chiefly, however, for locomotive firing), and the slack for making coke. The specific gravity is 1.272.

Analyses of Pratt Coal.

Authority.	I. Phillips.	II. McCalley.	III. Min. Resources of U. S., 1892.	IV. Lupton.
Fixed carbon,	67.90	61.670	64.30	63.82
Volatile material,	29.80	31.480	32.08	31.85
Moisture,	......	1.58	1.07	1.12
Ash,	2.30	5.416	2.08	3.21
Sulphur,	0.83	0.918	0.47	0.70

Ultimate Analyses.

Authority.	I. Phillips.	II. Phillips.
Carbon	75.82	75.05
Hydrogen	10.52	9.91
Oxygen (by difference)	7.51	8.95
Nitrogen	1.73	1.62
Sulphur	1.07	0.97
Ash	2.00	2.35
Moisture	1.35	1.15
Total	100.00	100.00

The coal from the mines is dumped on an ordinary bar-screen, with spaces 2½ inches in the clear, all going over this screen being shipped as lump. That which passes through is received on a shaking bar-screen, with ¾ inch spaces, which separates the nut from the slack. All the coal going through this screen is sent to the washer. Of an output of 700 to 800 tons per day, about 40 per cent. is shipped as lump and nut, and the remainder is washed for the coke-ovens.

The impurities occurring in the coal are pyrites, mineral charcoal, and slate partings. As delivered at the tip there will be also foreign slate (shale), and dirt from the top and bottom of the seam. The pyrites is found generally in thin sheets or local partings, and not in nodular form. The mineral charcoal also occurs in limited streaks, neither of these impurities forming regular partings of any extent. The slate parting is persistent, varying from a mere trace to a couple of inches in thickness and occupying a constant position about eight inches from the roof. The other impurities mentioned are due entirely to careless mining. The pieces of slate and pyrites in the slack-coal are for the most part thin, and have a length and breadth several times as great as their thickness. The specific gravity of the slate is from 1.8 to 2.

In mining the coal, single entries, with air-courses, are driven, and the workings are opened out by "room-and-pillar." The rooms are made 13 yards wide by 100 to 120 yards in length, the pillar left being 7 yards in breadth. All mining is done by hand, the coal is undercut with the pick and generally brought down by the use of black powder. Sometimes no explosives are needed. The bottom varies, being often a fire-clay, sometimes a soft, and again a very hard, slate. The roof is a sandstone in some parts, a gray slate in others. Between the coal and the roof there is usually, but not always, a thin "muck" parting.

Fig. 1.

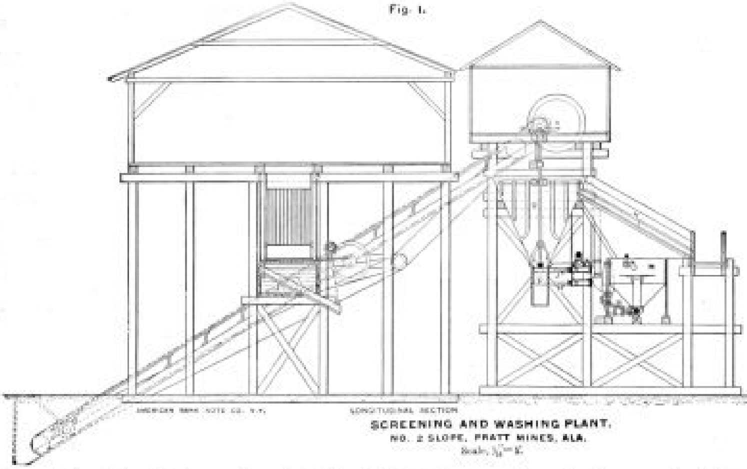
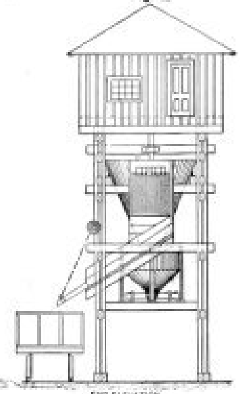


Fig. 2.



SCREENING AND WASHING PLANT,
NO. 2 SLOPE, PRATT MINES, ALA.
Scale, $\frac{1}{16}$" = 1'.

THE WASHING-PLANT.

This consists of a 400-ton Robinson washer, with the necessary appliances for handling the coal before and after washing. The coal that passes through the nut-screen descends by gravity to a 16-inch screw-conveyor, with a pitch of 18 inches (*A*, Fig. 3). It is horizontal, 19 feet 6 inches long, and has, at a speed of 25 revolutions per minute, an actual capacity of 75 tons per hour. This screw delivers to a flight conveyor (*B*, Fig. 3) with a slope of 32 degrees, the flights being 7½ by 13 inches and set 21 inches apart. As shown in the figures, the lower end of this conveyor is below the railroad-level, that it may take coal from the screw (*C*, Fig. 1), which is used at night, when coal from other mines is brought in by rail. The coal is delivered by this elevator over the central part of the washer-tub (*D*, Fig. 1). This is a cone-shaped tub of iron, 11 feet high, 11 feet 6 inches in diameter at the top and 22 inches at the bottom, the shell being ½-inch in thickness. At the lower end is an annular compartment, connecting with the water-supply, and so perforated as to admit the water to the cone in the form of a number of small upward jets. In the center of the cone is a vertical shaft, reaching nearly to the bottom and carrying four wooden arms, to which are attached iron stirrers. Short stirrers are also attached directly to this shaft near its lower end. Motion is derived by means of gearing from an engine above.

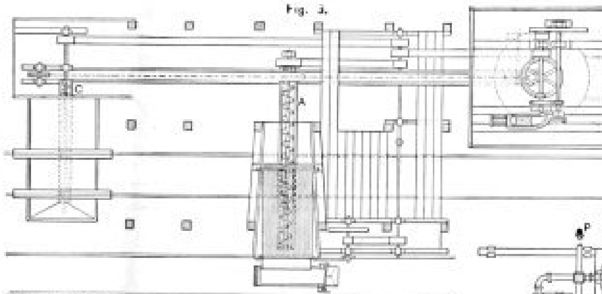
The slack dropped from the conveyor into the washer starts to descend, but is met by the ascending currents of water, and the particles of coal are stopped in their downward career and carried up and over the discharge (*E*, Fig. 2), while the heavier impurities continue to the bottom. This separation is assisted by the continual agitation caused by the stirrers, which make 8 revolutions per minute, and are so arranged that the two sets travel different paths. The refuse material collects in the chamber (*F*, Fig. 1), closed at the bottom by the valve (*H*). When the attendant is satisfied that this chamber is full of slate, the valve (*J*) is to be closed and the lower valve (*H*) opened, discharging the waste into a car without at all interfering with the process of washing. But in practice the waste is allowed to accumulate in the bottom of the cone, and emptied three or four times an hour by working the valves until it is certain that about all the refuse has been taken out. At first the valve-levers were operated by hand, requiring two and sometimes three stout men. But this method has been replaced by an arrangement of steam-pistons, so that the valves are now worked by one man without exertion. At the time when these notes were taken the slate was hauled away by a mule and driver; but it is intended to do away with this arrangement, and run the car by rope, so that one man can do all the work for the washer.

The cleaned coal and water passing the overflow (*E*, Fig. 2) are received on the screen (*K*, Figs. 1 and 3). At first there was but one screen, of steel, with ⅛-inch perforations. It did not drain the coal satisfactorily, and wore out in a very short time. The present arrangement consists of two screens, both of manganese bronze. The upper one is ¼-inch thick, with ⅜-inch perforations, ⅝-inch from center to center. The inclination is 30 degrees, and the screen is 4½ feet wide by 15 feet long, the last three feet, however, being blank. The fine coal and water that pass through this upper screen fall on the screen (*L*, Fig. 1), of No. 20 metal, having $\frac{1}{32}$-inch perforations, the coal from both screens discharging into a chute, which empties into the railroad cars. The water and sludge passing through the lower screen go to the tank (*M*, Fig. 1), from which the pulsometers draw.

In the English and the earlier American plants this tank was merely a "sump" for the pulsometers. But even with $\frac{1}{32}$-inch perforations there is a considerable amount of solid material—fine coal, slate and pyrites—contained in the water. As all the water, except that carried away by the washed coal, is used over again, the effects of the attrition of this material in the pumps and pipes is serious. Valves quickly wear out, and at one plant in the Birmingham district a pulsometer lasted only eighteen months. Again, with the simple tank this fine sediment—and especially the slate and pyrites—settles on the bottom, accumulating until it acquires a considerable height above the level of the discharge-pipe from the tank to the pumps. This, after a while, slips down with a rush and clogs up the pumps to such an extent as to prevent them from working. Daily shoveling was required to overcome this annoyance.

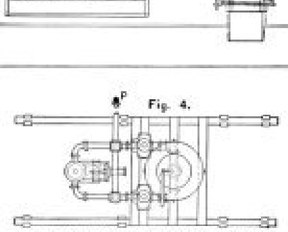
After experience of this sort at the Shaft No. 1 washer, Mr. Erskine Ramsey, Chief Engineer of the Tennessee Coal, Iron and Railroad Company, devised a tank that has been used at the No. 2 Slope plant with gratifying success. As shown in Figs. 5 and 6, it is an iron tank, cylindrical in section at the top, funnel-shaped at the bottom. In this tank is a circular deflecting-plate (*a*, Fig. 5). The water, charged with fine coal and impurities, is delivered into the top and at the center, so that there may be an even distribution over the entire surface of the plate. The flow of the water, on entering the tank, is indicated by the arrows in Fig. 5. With this current of water are carried the fine coal-particles, while the impurities, owing to their greater specific gravity, drop from the current, as indicated in the sketch, into the comparatively still water below the level of the mouth of the pump-supply pipe (*b*, Fig. 5), and collect in the bottom of the tank. From here this refuse is removed by means of a valve (*c*) discharging the sludge into a trough, by which it is carried to the waste-car under the washer-tub. The relation between the diameters of the deflecting-plate and the tank is a

Fig. 3.



SECTIONAL PLAN, TOP SCREEN REMOVED.

Fig. 4.



SECTIONAL PLAN, SHOWING PIPE CONNECTIONS.

SCREENING AND WASHING PLANT,
NO. 2 SLOPE, PRATT MINES, ALA.
Scale, $\frac{1}{16}$" = 1'.

point depending on the amounts of coal and of impurities in the fines and on the difference in specific gravity of these materials. With too small a plate the impurities will go to the pumps with the coal. With too large a diameter the coal will not be carried along with the current, but will be lost with the slate. Once regulated for a given coal, the results are distinctly good, as will be seen from analyses of refuse at the No. 2 Slope washer, given below. In connection with this tank is the valve for supplying the fresh water needed by the washer, automatically regulated by a float (*g*, Fig. 5, and *N*, Fig. 1).

The water, freed from its heavier impurities and augmented by the necessary amount from the fresh-supply pipe, is taken by the pulsometers through the central pipe (*b*, Fig. 5), and the connections (*e*, *e*, Fig. 6), and pumped directly into the washer-tub. This is an innovation on former practice, the old plan being to pump into a tank 40 to 60 feet above the bottom of the washer, with a discharge-pipe from this tank to the washer, in order to maintain a constant head. At this plant the same object is accomplished at less expense. The pipes between the pulsometers and the washer are connected to a stand-pipe (*P*, Fig. 4) 80 feet in height and open at the top. This acts as a balance on the inflowing current, and is of especial advantage when, as sometimes happens after a stoppage, the material in the washer becomes packed. The pumps then force water up the stand-pipe, until a head is developed sufficient to force a way through the obstructing stuff. Seldom has this column-pipe overflowed.

The engine that drives the washer-machinery is single, 10 by 16 inches, with 3-inch steam-supply. It furnishes also the power for operating the two screws, the elevator, and the shaking screen. The steam-plant includes six boilers, each 46 inches in diameter by 26 feet long, with two 15-inch flues, and fired with "run-of-mines" coal. Three boilers are in use, carrying 85 to 90 pounds steam-pressure, and supplying steam for the pair of hoisting-engines at the slope as well as for the washer-engine. One fireman is employed.

One man does all the work at the washer. He must watch the engine and keep it and the other machinery oiled; operate the main slate-valves three or four times an hour, and also the sludge-tank valve, and load the washed coal into the railroad-cars. He is by no means overworked in attending to these duties, and will have ample time to run the refuse-car when the rope-haul for it is introduced. For the same capacity, even the trough-washers can hardly excel, if they can equal, this labor record.

The cost of a Robinson washing-plant must vary with the particular conditions at each locality. Basing the estimate on the records of several plants in Alabama and Tennessee, the total cost of a 400-ton plant complete and ready for washing, including machinery for supplying the coal and disposing of it after washing, and also the royalty to the owners of the patent-rights, may be put at from $5,000 to $8,000. The cost of the washer-tub and its immediate appliances would be about $1,000. The cost of repairs is low; in fact, to the washer proper, there will be almost no repairs needed. But water-valves, pumps, screens, elevators, etc., need attention and renewal from time to time, which are chargeable to the account of the washer.

RESULTS.

Perhaps the first question arising is that of actual working capacity. At this Pratt mines plant the average output has been for many months fully up to the nominal capacity of 400 tons. Occasionally, for several hours at a time, the output has been at the rate of 600 and more tons, per day of ten hours. It is not likely that the quality of the product on these occasions could have been equal to that obtained in treating a normal quantity. From its appearance to the eye this was indeed claimed; but no analyses were made to substantiate it. It may be noted here that the output in clean washed coal may be double the nominal capacity, when nut-coal free from slack is used. On the other hand, if only very fine material be used, for instance, coal from a disintegrator, probably not over 200 tons a day could be cleaned.

TABLE I.—SLACK COAL, BEFORE WASHING.

Sampled 1893.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
November 1	30.53	63.28	6.19	1.53
" 2	27.64	60.20	12.16	1.50
" 3	30.12	61.86	8.02	1.55
" 4	29.11	60.41	10.48	1.57
" 6	29.35	59.41	11.84	1.27
" 7	30.41	63.51	6.08	1.65
" 8	29.28	63.42	7.30	1.49
" 9	30.45	58.25	10.50	1.39
" 10	30.23	57.03	12.74	1.60
" 11	28.64	56.66	14.70	1.34
Average	29.55	60.26	9.98	1.48

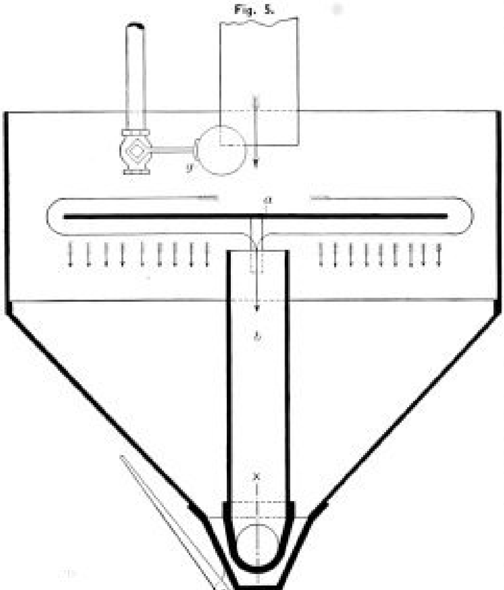
From the analyses of Pratt coal already quoted it will be seen that the average ash is about 3 per cent. These figures were obtained presumably from lump-coal. Table I. gives a series of analyses of the slack used at No. 2 Slope, taken during regular working of the plant and sampled between the last screen and the washer. The spaces between the screen-bars are $\frac{5}{8}$-inch in the clear; and everything that passes through this screen goes to the washer without further treatment.*

TABLE II.—WASHED COAL.

Sampled 1893.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
November 1	25.63	68.69	5.68	1.42
" 2	29.76	63.65	6.59	1.50
" 3	28.66	66.43	4.91	1.46
" 4	30.92	61.55	7.53	1.19
" 6	31.00	61.37	7.63	1.31
" 7	31.10	63.95	4.90	0.86
" 8	31.64	63.78	4.58	1.12
" 9	32.59	64.05	3.36	1.17
" 10	32.61	61.19	6.20	1.28
" 11	33.01	60.49	6.50	1.24
Average	30.69	63.51	5.78	1.25

Table II. shows the results of investigations of the washed product, samples being taken from the coal as it was delivered to the railroad-cars.

Fig. 5.



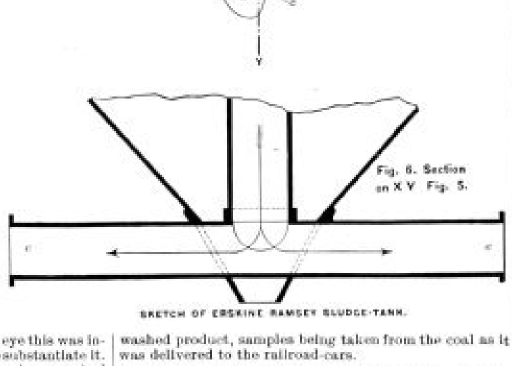


Fig. 6. Section on X Y Fig. 5.

SKETCH OF ERSKINE RAMSEY SLUDGE-TANK.

TABLE III.—COMPARISON BETWEEN TABLES I. AND II.

	Volatile and Combustible Matter.		Fixed Carbon.		Ash.		Sulphur.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
	%	%	%	%	%	%	%	%
1		16.05	8.55			8.24		7.19
2	7.67		5.73			45.80		
3		4.85	7.39			28.77		5.81
4	6.22		1.88			28.15		24.20
6	6.35		4.00			35.56	3.15	
7	2.27		0.66			19.41		47.88
8	8.65		0.56			37.26		24.83
9	7.03		10.00			67.58		15.82
10	7.87		7.39			51.33		20.00
11	15.26		6.73			56.28		7.46
Average	3.86		5.22			42.08		15.54

It will be seen that the average ash in the coal has been reduced from 9.98 to 5.78 per cent. In other words, the washed coal contains 42 per cent. less ash than the unwashed. The reduction in sulphur is over 15 per cent., and the gains in volatile material and fixed carbon are about 4 and 5 per cent. respectively. Table III. gives in detail the effects of washing, calculated from the above tables as percentages on the figures for the unwashed coal.

Table IV. gives analyses of the washed coals of larger dimensions only, samples being taken from that part of the product which goes over the screen with $\frac{5}{8}$-inch perforations.

The average of these results, compared with those of Table I., shows a reduction in ash of over 48 per cent., a reduction in sulphur of nearly 15 per cent., and gains in volatile material and fixed carbon of about 5 and 6 per cent. respectively. A detail statement of the results of Table IV. compared with those of Table I. is given in Table V.

TABLE IV.—WASHED COAL, OVER $\frac{5}{8}$-INCH SCREEN.

Sampled 1893.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
November 1	31.13	63.82	5.05	1.46
" 2	29.08	64.99	5.93	1.47
" 3	30.40	65.07	4.53	1.28
" 4	29.82	66.48	3.70	1.50
" 6	30.67	63.98	5.95	1.09
" 7	31.14	63.71	5.15	1.42
" 8	30.99	63.75	5.26	1.02
" 9	32.01	63.35	4.64	1.13
" 10	32.44	62.28	5.28	1.25
" 11	33.06	60.82	6.12	1.12
Average	31.01	63.82	5.16	1.27

TABLE V.—COMPARISON BETWEEN TABLES I. AND IV.

	Volatile and Combustible Matter.		Fixed Carbon.		Ash.		Sulphur.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
	%	%	%	%	%	%	%	%
1	1.96		0.85			18.47		4.57
2	5.21		7.95			51.23		2.00
3	0.93		5.19			43.51		20.65
4	2.44		10.05			64.69		4.46
6	3.15		8.42			49.75		14.28
7	2.40		0.31			15.29		13.94
8	5.84		0.52			27.94		31.54
9	5.13		8.76			54.95		18.70
10	7.31		9.21			58.55		21.88
11	15.43		7.34			58.37		16.42
Average	4.93		5.73			48.29		14.77

It must be remembered that this washer is treating at one operation all sizes of coal from $\frac{5}{8}$-inch in thickness down to fine dust. Many pieces of the thickness named exceed it in their other dimensions, as is natural with a separation by bar-screen only. It could not be expected that a current and speed suitable for the larger dimensions would make as good a separation of the finer materials.

Table VI. gives a series of analyses of the washed coals that pass through the $\frac{5}{8}$-inch holes and over the screen with $\frac{1}{16}$-inch perforations.

TABLE VI.—WASHED COAL, UNDER $\frac{5}{8}$-INCH SCREEN.

Sampled.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
November 1	29.13	64.05	7.80	1.62
" 2	29.15	66.36	4.49	1.42
" 3	29.30	60.82	9.88	1.53
" 4	29.71	60.44	9.85	1.60
" 6	30.21	63.34	6.45	1.31
" 7	29.88	62.74	7.38	1.24
" 8	30.47	62.61	6.92	1.25
" 9	28.02	58.93	13.05	1.25
" 10	30.12	58.33	11.55	1.32
" 11	30.37	59.84	7.79	1.26
Average	29.54	61.75	8.52	1.40

Comparing the average results of Tables VI. and I. it is seen that the reduction in ash is about 14.5 per cent., in sulphur 6 per cent., with practically no change in volatile matter, and 2 per cent. increase in fixed carbon. A detailed comparison is given in Table VII.

TABLE VII.—COMPARISON BETWEEN TABLES I. AND VI.

	Volatile and Combustible Material.		Fixed Carbon.		Ash.		Sulphur.	
	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
	%	%	%	%	%	%	%	%
1		7.80	1.23		26.01		5.98	
2	5.82		10.23			63.08		5.33
3		2.72		1.68	23.19			1.29
4	2.46		0.05			6.01	1.91	
6	3.63		7.34			45.52	3.15	
7		1.74		1.21	21.38			21.85
8	4.07			1.27		5.23		16.10
9		7.98	1.16		26.70			10.07
10		0.36	2.28			9.34		5.00
11	6.04		5.61			47.00		5.97
Average		0.03	2.30			14.64		6.04

A glance at this table and at Table V. shows at once

* These analyses and those in the other tables following were made by Dr. W. B. Phillips.

that the washer, working under existing conditions, is better adapted to the larger-sized coals than to the fines. Yet it is economical to continue as at present, since the amount of product passing through the ⅜-inch screen is small, not over 10 per cent. of the total, and for this amount a secondary treatment would scarcely pay.

With regard to the composition of the refuse, two sets of analyses are presented, the first (Table VIII.) being of coarse material taken from the main washer-tub, the second (Table IX.) of the fine stuff from the sludge-tank.

TABLE VIII.—COARSE SLATE REFUSE.

Sampled.	Volatile and Combustible Material.	Fixed Carbon	Ash.	Sulphur.	From Solution, Sp. gr. 1.235.	
					Coal.	Ash in Coal.
					%	%
November 1..	14.04	19.85	66.11	2.91	11.00	37.20
" 2..	14.46	31.14	54.40	2.11	6.81	13.20
" 3..	19.27	34.76	45.97	1.93	26.20	23.10
" 4..	16.25	25.96	57.79	2.41	14.17	33.20
" 6..	15.15	24.54	61.31	1.79	12.50	24.84
" 7..	18.10	35.39	46.51	2.09	21.80	23.50
" 8..	13.63	23.43	62.94	1.67	9.52	21.60
" 9..	14.71	21.44	63.85	1.53	4.87	11.86
" 10..	11.82	15.80	72.38	1.81	......	......
" 11..	12.79	17.02	70.19	1.66	3.80	18.03
Average........	15.02	24.93	60.05	1.99	12.29	23.16

As the amount of this refuse in a day's run is about 18 tons, and the coal-contents, as shown by the above table, are 12.29 per cent., there will be 2.3 tons of coal lost in the average run. The irregularities in coal contents are due partly to the use of a bar-screen and partly to the work of the attendant. Large lumps of coal are occasionally passed by the screen, and of course descend with the slate. The attendant may sometimes open the the valves too often, and cause a loss of coal.

The value of Mr. Ramsey's tank in getting rid of the worthless material is shown by the following analyses. About 7 tons per day are drawn from it, only 16 per cent. of which, or 1.1 tons is coal. The entire loss in coal then on 425 tons of material treated, is 3.4 tons or

TABLE IX.—REFUSE FROM RAMSEY SLUDGE-TANK.

Sampled.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.	From Solution, Sp. gr. 1.235.	
					Coal.	Ash in Coal.
					%	%
November 1..	17.85	34.20	47.85	2.93	7.40	8.60
" 2..	17.96	26.00	56.04	2.43	6.81	13.20
" 3..	16.31	29.25	54.44	2.72	14.00	14.60
" 4..	23.39	46.78	29.83	2.45	32.80	10.60
" 6..	24.29	46.59	29.12	2.19	25.37	9.80
" 7..	22.94	48.24	28.82	2.23	23.00	8.20
" 8..	21.91	46.54	31.55	2.15	8.90	7.00
" 9..	19.85	33.40	46.75	1.99	17.35	7.75
" 10..	15.25	23.13	61.62	2.08	3.58	10.87
" 11..	20.16	39.41	40.43	2.48	21.17	10.00
Average........	19.99	37.35	42.65	2.36	16.03	10.06

0.8 per cent. of the total. The total refuse material, slate and coal together, is 25 tons or 6 per cent.

The amount of fresh water needed to take the place of that carried off with the refuse and washed coal was found to be 14,050 gallons. On the day of this test 400 tons of washed coal were produced, and the washer was running for 11 hours. The average water per ton of washed coal was 35.1 gallons; average per minute, 21.3 gallons. Hourly measurements were taken, showing from 24 to 51.3 gallons of water per ton of coal. This irregularity was due to the varying coal-supply which, depending on the way coal came out of the mine, was sometimes only 25 tons (washed) in an hour.

The cost of washing per ton of washed coal is low. The daily expenses may be estimated as follows:

For labor at washer..............................	$2.00
For labor at boilers, fuel, etc.,........................	4.00
For repairs and supplies,............................	3.00
Total,....................................	$9.00

This for 400 tons would be 2.25 cents per ton; and it is quite likely that the actual figures are still lower.

THE COKE.

The washed coal is carried in hopper-bottomed railroad cars to the ovens, and there dumped into a series of bins of 5,000 tons' capacity. From these it is loaded into 6-ton larries, hauled in trips of two by small steam

TABLE X.—48-HOUR COKE FROM UNWASHED COAL.

Sampled 1894.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
January 9..............	0.86	89.48	9.66	1.24
"	2.45	81.03	15.60	1.37
"	0.50	87.28	12.29	1.21
"	0.80	84.75	14.35	1.33
"	0.50	83.00	16.50	1.43
Average..................	0.62	85.70	13.66	1.31

locomotives. The ovens are all of the bee-hive pattern, 12 feet in diameter, and built with a height of 7 feet 9 inches, though the average height now is probably not over 6 feet 9 inches. The outside walls are of sandstone, the oven walls of fire-brick. Of the bottoms, some are of fire-brick; some of 12 by 12 by 3-inch fire-brick tiles; some of common red brick. They were built with the back 6 inches higher than the front, but many have no slope now. With unwashed coal the usual charge was from 4 to 4.5 tons. Since using washed coal this has been increased to about 6 tons, without any increase of of wages to the pullers, as the labor is less than when pulling coke made from unwashed coal. The ovens retain the heat better than before, in spite of the washed coal, being charged damp. Repairs to ovens are less than before using washed coal. All coke is quenched in the ovens.

TABLE XI.—48-HOUR COKE FROM WASHED COAL.

Sampled 1894.	Volatile and Combustible Material.	Fixed Carbon.	Ash.	Sulphur.
January 9..............	0.46	90.00	9.60	0.88
"	0.60	89.06	10.44	1.25
"	0.40	89.40	10.20	1.03
"	0.50	88.40	11.20	1.44
"	0.90	88.35	10.75	1.05
Average..................	0.54	89.04	10.43	1.13

A comparison of Tables X. and XI. shows that there was in the samples taken an increase of 3.9 per cent. in fixed carbon, a decrease of 23.6 per cent. in ash, and a decrease of 13.7 per cent. in sulphur, due to washing. A week's record of washed coke samples from stock house shows:

	1.	2.	3.	4.	5.	6.	7.	Average.
Ash......	10.68	8.80	9.57	10.40	9.93	9.40	9.40	9.73

Coke from the washed coal can be recognized at the door of the oven by the difference in the amount of braize. To determine the improvement in this respect, the weights of the ash-piles in front of a number of ovens were carefully taken, showing the average amount, when coke is made from unwashed coal, to be 521 pounds, and, with washed coal, 238 pounds, or a saving of 283 pounds of coke per oven. If the output from each oven is taken at 2.5 tons (the tests having been made with the same charge as customary when using unwashed coal) the saving is 5.66 per cent. There will also be saved a certain amount of the braize made in forking the coke from the oven-door to the car, in the unloading of the cars, and the loading into furnace-buggies. Weights at the furnaces of braize left in cars after unloading showed 3 per cent. in the case of unwashed coal, and 1 per cent. when washed coal had been used.

This gain in output of marketable coke is sufficient, without charging the furnaces any higher price for their fuel, to compensate the mines for the cost of washing, and for the material formerly put into the ovens but now sent to the waste dump. Assuming a selling-price of $2 per ton, the saving in braize at the ovens is 11.32 cents, in the cars 4 cents, or in both items 15.32 cents per ton of coke. The refuse from washer, formerly coked, is 6 per cent. of the total. To make a ton of coke, 1.67 tons of coal are required. Six per cent. of this, or 0.1 ton, may be called, from the standpoint of the mines, the loss in "coal" per ton of coke. Assuming, as an an average cost of coal, 80 cents per ton, the increase in cost of coal per ton of coke is 8 cents. To this must be added the cost of washing, 2.25 cents per ton of coal, or, 3.75 cents per ton of coke. The total is 11.75 cents, against which there is, as above, a saving of 15.32 cents, or a net saving of 3.5 cents per ton of coke, due to washing.

In the furnace, the washed coke is distinctly advantageous. There is less of that fine stuff from which no valuable service is realized. Comparative tests of crushing strength have not been made; but the "washed coke" undoubtedly will sustain a heavier burden than the unwashed. A few words from a letter of an official of one of the Birmingham companies will show the estimation in which the once despised washers are now held:

"The cost of coke per ton of iron made will be about 50 cents less for the month of March on the furnaces using washed coke. From the present work of the coke in the furnaces it would pay to wash the coal, even though all the waste was coal."

Practical operations in Alabama, Georgia, and Tennessee, during the past four or five years, have proved that this washer is well adapted to such coals as those of the southern field, containing a moderate quantity of impurities. Its advantages may be summed up as follows:

a. Low first cost.
b. Low labor-cost.
c. Compactness of plant.
d. Economy of water.
e. Small waste of coal.
f. Ability to treat with good results materials not closely sized.

NOTE BY THE SECRETARY.—Comments or criticisms upon all papers, whether private corrections of typographical or other errors, or communication for publication as "Discussion" or independent papers on the same or a related subject, are earnestly invited.

The Abendroth & Root Manufacturing Company, 28 Cliff street, New York City, manufacturers of the Improved Root Water Tube Boiler have been awarded the 626 h. p. boiler contract from the Union Car Company of Buffalo, N. Y., and a 500 h. p. contract from the Reading Steam Heat and Power Company of Reading, Pa. They are also erecting in New York City, 300 h. p. in the College of Physicians and Surgeons; 2 boilers in the Baptists Home; 1 boiler in the Farmly Building and 2 boilers for the Sing Sing Electric Lighting Company.

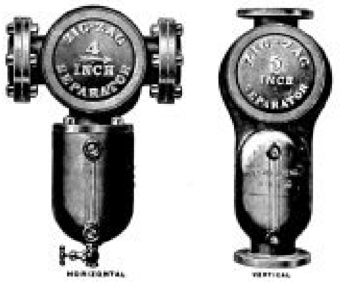
Steam Separators.

The use of steam separators, has, during the past few years, become recognized as a necessity. They enable the engine to work on dry steam, prevent hammering in the cylinder and increase the efficiency of the engine and at the same time reduce the liability to breakage.

Owing to the low cost of fuel at coal mines there is a strong conservatism manifested by the managers, in the trial or adoption of improved ideas in raising and utilizing steam. This conservatism is not so marked at metal mines. It is a trait, that while commendable in some instances, is not commendable in all. The same degree of efficiency and durability in coal mining operations should be and can be secured, as in other industries. Too much conservatism tends to prevent this.

Every expert in steam advocates the use of a good separator. Such a mechanism, known as the "Zig Zag Separator" manufactured by J. S. Stephens, 315 Dearborn St., Chicago, is shown in the accompanying illustrations.

This separator is so constructed that it has a direct, undivided passage for the steam, the distance over which the steam has to travel being not greater than 5 per cent, more than the straight-line distance from face to face of the flanges. The area of the steam passage is 10 per cent. larger than the pipe, thus giving full and free passage to the steam without obstruction or loss of pressure. While this separator has all the advantages that may be obtained by the diaphragm or baffle-plate style, it also combines with this the advantages of the centrifugal form, the centrifugal action or change of direction of the current of steam being shorter, quicker and much more effective than is usual in this construc-



tion, and having the further advantage that the steam is spread out in a thin layer or ribbon-shaped current, giving the greatest facility for separation by centrifugal action. This centrifugal action is combined with serrated separating surfaces, placed at an acute angle to the flow of the steam. The serrations present right angle surfaces to the outer diameter of the ribbon-shaped steam current in each turn it make to obtain separation by centrifugal action, while the turns over these surfaces being reverse curves present each side of the current of steam alternately to the serrated impurity-catching surface. The main current of steam passing over these surfaces at an acute angle has a constant tendency to assist in the separation and removal of any entrained water or foreign substance.

The water and impurities are forced into the receiving chamber by the rapid passage of the current of steam through the separator, while the purified steam passes off at right angles to the direction imparted to the water without the crossing of the two currents.

The vertical Zig-Zag Separator has been designed especially for live steam work, to be placed directly on top of the throttle valve of the engine (where any live steam separator should be, to be most effective and do its duty). This style is tapped for the connection of the lubricator, either right or left handed, as ordered, and fitted with nickel-plated, heavy body gauge cocks and straight-way drain valve.

If the dimensions are given, or a paper template is furnished, the flange will be fitted, drilled and finished, and bolts furnished ready to attach to the flange of the throttle valve.

Culver Valves and Separators.

Those of our readers who have seen the Culver valves and separators, together with those who read the descriptions of those excellent devices, will be pleased to know that Mr. W. B. Culver, the inventor, has turned over the management of the business of the Culver Mfg. Co. to his son Geo. W. Culver, and S. S. Derman. These two young men will give the business that attention which it failed to receive in the past, on account of Mr. W. B. Culver's professional engagements. The new men in the firm are young men who will push the business vigorously. Mr. Geo. W. Culver is a practical machinist, and Mr. Derman is a young business man of hustling proclivities. All letters of inquiry and orders received in the future will receive courteous and prompt replies, and it is safe to say that in a very short time Culver valves and Culver separators will be in use at many prominent steam plants in all parts of the country. The valves and separator are of the simplest possible construction, and the excellent results following their use have made them very popular wherever they have been introduced. The merit of the valves is apparent to every engineer or machinist who has ever seen them, and their apparent merit has been amply proved by practical use at a number of plants. Circulars descriptive of the valves and separator together with prices can be secured promptly by addressing the Culver Mfg. Co., Scranton, Pa.

The Los Angeles Electric Company, Los Angeles, Cal., use "Stevedore" transmission rope for their drive, and have recently ordered 3,000 feet for this purpose from the C. W. Hunt Company, New York City, who are the sole manufacturers.

A NEW TYPE OF BOILER.

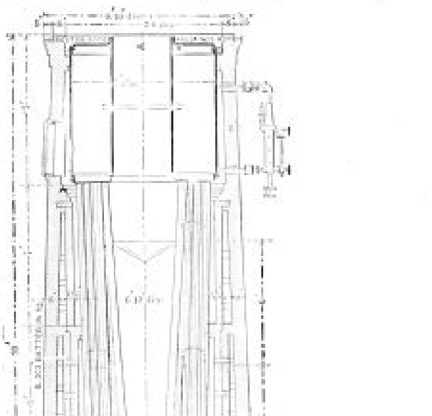
Description of the Cahall Vertical Water Tube Boilers.

Messrs. H. E. Collins & Co. of Pittsburgh, whose advertisement appears in this issue, in reply to our request for a description of the Cahall boiler, send us the following article which is worthy the attention of all boiler users:

"The Cahall Vertical Water Tube Boiler, manufactured by the Aultman and Taylor Machinery Co. of Mansfield, Ohio, for which we are the sole agents in the United States, consists of two drums arranged one above the other, made of best mild, open-hearth flange steel, and connected with 4" lap-welded best charcoal iron tubes. These tubes are vertical, are perfectly straight throughout their entire length, and are expanded into the drums at each end, making lasting and absolutely tight joints.

"The upper or steam drum has an opening through its center for the exit of waste gases. These gases although reduced to a very low temperature in passing through the closely grouped tubes of the boiler, will impart most of their retained surplus heat to the metal sides of the passage through this upper drum, thereby tending to slightly superheat the steam in the chamber above. The water line in the upper drum is about a foot above the bottom of the drum; the drum itself being about six feet high in the clear inside, leaving a space of five feet between the surface of the water and the point at which the steam is drawn off from the boilers, thereby precluding any possibility of the carry-over of water in the steam, either in the form of supersaturation, or mechanical entrainment.

"An external circulating pipe comes out from the upper or steam drum, just below the water level, and is carried downward, outside the brick work, to a point just below the tube sheet of the lower drum, where it enters that drum. There being no steam whatever in this external circulating pipe, and no possibility of making any, and there being in the tubes connecting the two drums, steam in greater or less proportions, the result is (the volume in the external pipe having a considerably greater specific gravity than the mixture of steam and water in the tubes), a very rapid, positive circulation in one direction; the water in the tubes connecting the drums ascending to the steam drum, delivers this mixture of water and steam there, whereupon the steam separating at once from the water, after traveling the space of five feet from the water level to the top of the drum escapes, and the water which is left behind enters the circulating pipe and is carried down to the mud drum and again arises with its mixture of steam. As this mixture of steam and water coming from the upper end of the tube in the boiler, is in about the proportion of half steam and half water in bulk, and as steam at 100 lbs. pressure will occupy about 218 times the space occupied by the water itself, the water in the boiler (being thus delivered in the proportion of 218 parts water to one part steam in weight, at the upper ends of the tubes) will circulate through the boiler 218 times before finally becoming steam. This insures not only a rapid and steady circulation as mentioned, but also insures an absolutely uniform temperature of water in all the tubes, as every particle of fresh feed water being thus circulated 218 times before evaporation must necessarily mingle in such minute parts with the water already present in the boiler, that the water in one ascending tube cannot be different in temperature to that in any others. The boiler is thus relieved from any possibility of destructive strains from unequal expansion.



"The boiler rests upon four iron brackets riveted to the lower, or mud drum, supported upon four piers of the foundation, the entire structure standing without contact with the brick work, thus allowing the boiler every freedom for expansion, without in any way straining the brick setting. In all places where pipe connections are made to the boilers through the walls, they are encased in expansion boxes.

"Owing to the fact that the gases escape through the central opening in the upper drum, the upper tube sheet has a circular opening in its center, leaving a central open space between the tubes, which gradually narrows to the bottom tube sheet. Advantage is taken of this space, which is in the form of an inverted cone, to introduce deflecting plates, which cause the gases to be alternately thrown out and in throughout the whole heating surface, giving them a sweep at nearly right angles to the tubes, thereby extracting from these gases their heat, until they come to very nearly the temperature of the water contained in the boiler.

"This construction presents a form of boiler, which, while from its free direct circulation it gives a capacity per square foot of heating surface unsurpassed by any other boiler heretofore built, at the same time, owing to the direction of the gases over the tubes and the consequent rapid absorption of the heat therefrom, gives an economical performance equaling that of any other boiler ever made.

"The space occupied by each 250 h. p. boiler set in continuous battery is about 9 ft. front for each boiler by 17 ft. long, which is less floor space than occupied by any other boiler built.

"The upper, or steam drum, and the lower, or mud drum, of the boilers are equipped with the Cahall patent swinging man head. By simply taking off the nuts from the man heads (which are on hinges) and swinging them open, a man can place a light in the lower drum of the boiler and get into the upper drum (which is sufficiently large to admit of a man standing upright and walking around in it), and can in five minutes examine the condition of every tube in the boiler; and in case scale or sediment is discovered in any of them, he can in a few minutes run a scraper through the tubes and render them perfectly clean. It will be found in actual practice that the use of the scraper in these boilers will be very seldom necessary, as for instance, boilers in use for about two years have never, up to and including the present time, had a cleaner in a single tube.

"Right here it might be well to mention that very seldom is a tube in a water tube boiler burnt out on account of a general or uniform deposit of scale on its surface. Most tubes failing are burned because a light scale having accumulated in the tubes, patches of it become loose and fall to the bottom of the tube, and remain there, because the tube lies in an approximately horizontal position. There are many instances where boiler tubes were scaled uniformly to the thickness of an inch, without any loss from burning. On the other hand, a single patch of scale less than an inch in diameter and ⅛" thick, on an otherwise clean tube, frequently causes the tube to burn out completely at the point where the scale is deposited. It will be seen that, from the arrangement of the tubes in the Cahall boiler, any scale that might loosen will at once fall to the mud drum at the bottom, and if small enough can be readily blown out through the blow-off pipe; if too large to be blown out, it can be easily removed through the man hole on regular cleaning day. As the entire lower drum is removed from direct contact with the fire, the presence of scale in this drum can act in no way to the detriment of the boiler, the fire not being in contact with the drum, it would not burn, even were the drum allowed to become half filled with scale."

Messrs. Collins & Co. claim for the boiler that, "all materials furnished in and with this boiler are of the very best. The workmanship is of the highest grade known to the boiler-making art. The safety valves are all of the Ashcroft or Ashton Pop type, with nickle seats. The fittings and valves are all specially designed, extra heavy, and the best that money can procure.

"We are determined to make this the world's standard water tube boiler, and no care or expense will be spared to make it such. Our price is lower than that of many other competing makers, but this is not because our workmanship or material is in any way inferior, but because, in the first place, while we use every ounce of metal necessary or desirable in the boilers, we find that it is practicable to make them with a weight of material not much greater than 60 per cent. of that of our competitors, and second, because we are perfectly satisfied with a close manufacturer's profit.

"Owing to the external combustion chamber, roofed with a heavy fire brick arch, which becomes incandescent shortly after the boiler is fired and radiates directly on top of the green coal its intense heat, the Cahall boiler can be operated with less smoke than any other boiler we know of can with the ordinary smoke preventing devices attached. Furthermore, owing to the direct upward passage of all gases and full free openings, we can with a comparatively short stack, obtain in the furnace a draft pressure that is not possible with most other boilers. For instance, in tests made with a stack only 50 feet high, a draft pressure in the furnace of over ½" was attained, which is a result that we doubt could be obtained from any other water tube boiler with a stack 100 feet high. This heavy draft causes a very rapid combustion of fuel per square foot of grate, with the consequent high initial temperature of gases, which all engineers of to-day admit is the primal requisite to either efficiency or economy in boiler practice.

"To sum up, we furnish a boiler equalled by none built, in quality of material, in excellence of workmanship, in surplus capacity per nominal unit, in evaporated efficiency, in small ground space occupied, in ease of examination and cleaning."

PREVENTION OF SCALE AND CORROSION IN BOILERS.

Owing to scarcity of water for steam purposes in many mining fields at this season of the year, a description of a device and resolvent, which when used together permit of the use of such water as is available, is of interest to our readers.

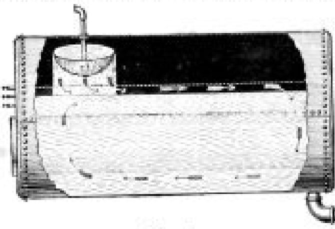


FIG. 1.

FIG. 2.

The Pittsburgh Boiler Scale Resolvent Co. of Pittsburgh, Pa., manufacture a cheap and efficient boiler scale resolvent and acid neutralizer from a product of petroleum that has met with much favor. It is highly endorsed by the officers of the Carnegie works, by the H. C. Frick Coke Co., the New York and Cleveland Gas Coal Co., and many others.

In fact the editor of this journal recently made several inquiries of prominent mining men as to their experience with this product and in every case received an answer that unqualifiedly endorsed it. Mr. Howard Morton, president of the Pittsburgh Boiler Scale Resolvent Co. states that scale and corrosion can be prevented in a 50-H. P. boiler at a cost of ten cents per week.

With a view of making the Resolvent as efficient as possible, and to aid its work in the boiler by the mechanical action of the water itself, Mr. Morton has devised an apparatus for top feed that has proven very successful.

In the above cut Fig. 1 shows a two-flue boiler with the top feed. The arrows show the circulation of the water.

Fig. 2 represents the top feeding device.

A is a brass nipple with threads on each end.

C is a discharge cage of brass.

B is a copper pan which is fastened to the cage *C*, with nut locks, which are not shown in the drawing. *D D* are nut locks to fasten the nipple *A* on either side of the boiler plate through which it passes. A suitable packing is furnished to make it steam tight. The device is so simple as to be readily understood at a glance.

Water parts with its scale forming mineral at the boiling point (212° F.) When the water is fed into the boiler from the rear and bottom, it reaches the boiling point just about the time it is over the hottest part of the boiler.

The mineral thus precipitated fastens onto the fire sheets and soon hardens into scale. Some of it will pass upward through flues and tubes and attach thereto. By the time the water has returned to the bottom and rear of the boiler, it has left the greater part of its scale forming mineral on flues and tubes and sheets, and but a small portion is precipitated within the influence of the mud drum or blow off. Another serious objection to feeding a boiler from the rear and bottom is that water of a comparatively low temperature projected along the upper surface of the fire sheets when the under surface is subjected to a fierce heat of several hundred degrees results in cracking the plates and rupturing the seams. The greatest expense for repairs comes from this source.

Now suppose we feed from the top by means of the device shown in the engraving. The water passing out of the cage *C* fills the copper pan *B* where it becomes heated to a high temperature before it overflows in a thin sheet.

By the time it reaches the surface of the water in the boiler the mineral is separated, but instead of fastening to flues or tubes, is hurried backward along the surface by the rushing current and carried downward to the mud drum or within the influence of the blow off. By using the Boiler Scale Resolvent with this device the mineral is kept in solution and prevented from crystalizing into scale until such time as it can be removed by blowing down or washing out.

An absolute guarantee of the efficiency of the resolvent when used in connection with this device is given to every purchaser. The usual charge for the top feeding device is four dollars, but when a barrel of the resolvent is furnished, one of the feeding devices is furnished free. If a number of boilers are fitted with the device, a charge of four dollars is made for each device furnished except the first one. Then with each subsequent barrel of resolvent purchased, the price of one top feed device is deducted until all the boilers are clear of cost in this particular. The purchaser of the device and the resolvent is the sole judge of its merit. If it does not do as represented, the company will make no charge.

Every man familiar with steam raising knows that petroleum alone is an excellent scale and corrosion preventitive, but that it volatilizes at a very low temperature. The Pittsburgh Boiler Scale Resolvent retains all the desirable properties of petroleum and does not volatilize until a temperature far in excess of that found in boilers is reached.

Written for THE COLLIERY ENGINEER AND METAL MINER.

MINE SURVEYING.*

LATEST AMERICAN IDEAS AND MOST APPROVED PRACTICE.

Rewritten for the use of Mine Officials, Surveyors and Engineers, from Lectures Delivered Before the Students of Columbia School of Mines.

(By Edward B. Durham, E. M.)

CHAPTER VI.

CONNECTING MINE AND SURFACE.

Having considered the ordinary methods of making underground surveys, and the apparatus used, there now remains the problem of connecting the mine survey with the surface, in order to determine the relative positions of points and lines above and below ground. It is the most difficult work in connection with underground surveying, and at the same time, must be done with great accuracy, as the correctness of the orientation of the whole underground survey depends on it.

In the days when the mine surveys were made with the magnetic needle, the meridian was determined underground by means of it, taking the precaution to remove all iron from the vicinity.

With the introduction of the transit into mine work, came the necessity of a more accurate way of orienting the underground survey. The first methods, naturally, used the transit, but, as the mines became deeper, new problems were presented which could not be solved by it with accuracy, and other methods, namely plumbing, had to be employed.

WITH THE TRANSIT.

Flat Inclines.—Where the entrance to a mine is by a tunnel or a slope with less than 40 to 50 degrees of inclination, the survey can be run in the usual way and without special apparatus. If quite flat, the elvations can be determined with a wye level, but if much inclined they must be obtained by the vertical angles and distance. The only difficulty in the work will be the inconvenience in using the instrument, owing to lack of good footing and the awkward positions necessary as the pitch increases.

Steep Inclines.—As the pitch becomes greater than 40 to 50 degrees, the line of sight through the telescope will strike the compass box and shut off the view and special methods must be used.

The eccentric telescopes, already described, throw the line of sight beyond the edge of the plates, and so make it possible to take steep sights downward.

One design is placed on top of the main telescope of the transit, and the other is fastened to one end of the horizontal axis. They are adjusted so as to be in the same plane as the main telescope and parallel to it. If it is placed on top, and is in proper adjustment, the horizontal angles read with it will be the same as if read with the main telescope, but the vertical angles, as read from the vernier will not be correct, unless the signal has been raised, perpendicular to the line of sight, a distance equal to the distance between the two telescopes. The vertical angle might be read with the top telescope, the same as with the main one, without regard to its being incorrect, and, afterward, the amount of error could be calculated and the correction made in the angle, thus: If we let A = a point at the horizontal axis of the transit, B = a point on the top telescope on a perpendicular from the main telescope at A, and C = the signal.

Then AC = distance between horizontal axis of transit and the signal.

AB = distance between telescopes.

BC = line of sight of the top telescope.

ACB = error in vertical angle due to sighting with the top telescope.

Then, since angle $ABC = 90°$,

Sine $ACB = \frac{AB}{AC}$ from which we can find the value of ACB, and subtract it, from the angle read, for negative slopes, and add it for positive slopes.

From this, it follows, that the mean of the vertical angles read with the top telescope at the two ends of a course, will give the true angle, since the correction, applied at one end, must be added to the angle as read, and at the other end it must be subtracted. In taking the second reading the horizontal axis of the transit and the signal must exchange places exactly, as is done with the instruments used for the three tripod method.

This calculation will have to be modified for lines, where the difference of the elevation of the two ends is less than the distance between the telescopes.

If the eccentric telescope is on one end of the horizontal axis, and in adjustment, it will be in the same plane through the horizontal axis as the main one and parallel to it.

The vertical angles as read on the vernier will be the true ones, but the horizontal angles cannot be read correctly unless the signals are offset from the point, a distance, perpendicular to the line of sight, equal to the distance between telescopes. It can be proved† that, the mean of two angles, one read with the side telescope on one side, and the other with it on the other, will give the true angle. This will allow the angle to be read by repetition, by taking the same number of readings with the telescope on one side of the center as with it on the other, and then dividing the final result by the total number of readings taken. The approximate determination of the angle, corresponding to the first angle of an ordinary set, would be found by mesuring the angle, once with the telescope on the left side and once with it on the right, and taking the mean of the two readings.

In setting up the instrument for steep sights care must be taken that none of the legs are in the way of the line of sight. Often it will be more convenient and safer to the man and the instrument, to clamp the transit to a heavy plank nailed across the shaft.

The horizontal angle is read by using the eccentric telescope for both sights. Owing to the many things liable to cause errors it is advisable to read several sets and to read and record every angle of the set, to aid in the detection of any error in observation, which would be apparent, if there was any change in the differences between consecutive readings.

The most likely cause of error in shaft work, with the open lamps, is, that the flames flicker badly, owing to the air currents. In sighting down, one is looking at the top of the wick tube which is not distinct, and in sighting up the body of the lamp is often in the way.

Here the illuminated target is far superior to the open lights, in that the target is at right angles to the line of sight, and the lines at which to sight are sharp and clear.

Having located the point down the slope, the transit is next set up there; if it is necessary to sight still further downward, the eccentric telescope will still be needed, but if the line is to be carried off horizontally, the eccentric telescope can be removed, and the upward sight taken with the prism eye piece, unless the sight happens to be so nearly vertical that one can not get the eye close to the telescope. The work at the bottom is more difficult than at the top, owing to the strained position in sighting upward, and dangerous on account of falling material.

The vertical angles must be read very carefully, as in steep lines they influence the horizontal distances much more than in flat ones.

If without an eccentric telescope, THE COLLIERY ENGINEER AND METAL MINER gives a method by which a line can sometimes be run up a steep slope, thus connecting the mine survey with the surface, by using a prism eye piece and running by foresight only.

To do this, set up the transit at the foot of the slope at a point *A*, when a point *B*, can be located from it, measuring both distance and angle, and in the prolongation of *A B* set a point *C*. Then set the transit at *B* and set a new point *D*, and in the prolongation of *B D* set the point *E*. Then read the angle *C B D* and determine the position of *D*, then move to *D*, and set a new pair of points reading the angle to the nearer one from the line *D E*. Continue in this way to surface, where the transit will be set at the mouth of the slope the signal will be set on the head frame and the angle can be read from it to some point of the surface survey. The angles may be recorded as deflection angles to the right or left, or they may be read by repetition, and then have 180° added to the result, when they will be the same as the ordinary horizontal angles. This scheme does away with all sights down the slope, which could not be made without an eccentric telescope.

The "School of Mines Quarterly" * gives an ingenious method suggested by S. W. Balch of getting a line down a shaft with the ordinary transit, by tilting it so the line of sight will clear the plates. The instrument is adjusted, while in the tilted position so that the centers will be inclined, only in the direction of the line to be thrown downward, then the horizontal axis will be horizontal and the telescope will revolve in a vertical plane. The transit can be set approximately in this position by means of the plate bubble parallel to the axis of the telescope. It can be accurately set with a stride level, or by turning the telescope so it will be exactly 90° from the line to be thrown downward, and then bring the bubble into the center of the tube with the leveling screws the vertical vernier being set at zero. The same result can be obtained, by setting the vernier at zero with the telescope in the plane of the line to be projected, then turn the telescope out so it will be level, and swing it to the right and left through small angles of equal size, and adjust by the leveling screws until the travel of the bubble is equal for equal deflections. The plates must be reset so zero will be in the vertical plane to be projected after each movement of the leveling screws.

When the horizontal axis has been leveled, and the plates are clamped with the telescope in the direction of the line to be projected, it can be swung downward, and one or two points marked in the underground workings. If only one point is set, the surface point will be the backsight but if two, the line between them can be used, as it will be parallel to the surface line. The point over which the instrument is set should be vertically under the center of the horizontal axis when the transit is tilted.

Besides throwing a line down in a vertical plane, a right angle can be turned with the transit in the tilted position without special calculations.

In the original article, the necessary formulas are deduced for turning any angle while the transit is tilted, but the angle could be turned first with the transit level, and the direction of the new line marked out, and then the transit could be tilted and the line projected downward.

Vertical Shafts.—In many of the text books are methods of transferring a surface line underground, by placing the telescope in the direction of the line to be projected, and then to swing the telescope down, marking two points in the mine in the vertical plane thus described, and then connecting the mine survey to the line between these two marks. Or the transit may be placed at the bottom, and a line of the mine survey thrown upward, and marked at the top by a point on each side of the shaft, and later the direction of the line between them can be determined. This could easily be done in large, shallow shafts, but the conditions in practice are not often such as to make it practicable.

This method was used in the Severn Tunnel,† where, owing to the wetness of the shaft and the jar of the pumps, the plumb-bobs were found to be useless. A large transit was set over the shaft, in the vertical plane through the center line of the tunnel, as determined by poles on each side of the Severn river. After the headings had been driven a short distance, in both directions from the shaft, a wire 300 feet long was stretched at the bottom; and carefully placed in line by the transit. This wire was then used as a base, from which the direction for the tunnel was obtained. The headings are said to have met exactly.

The ends of the wire were placed over the *V* threads of horizontal screws and stretched by weights. By turning the screws the position of the whole wire was shifted, as directed by signals from the man at the instrument, until it was in line. About 14 feet of it was visible from the transit, and this was illuminated by an electric light.

If there was no refraction, the errors would all be due to observation.

If the instrument were out of level about an axis perpendicular to the tunnel, the line would still be projected in a vertical plane, and if out about an axis parallel to the tunnel, the telescope would throw an oblique plane and the wire, if it was horizontal, would be placed parallel to the true position, and the error would be constant. This same principle was employed by Mr. E. A. Sperry at Leavenworth, Kansas,* for a connection between two coal mines, each worked by a vertical shaft. He tried plumbing with 5 pound plumb-bobs, but could not keep them steady, even after inserting four wings into each of them to offer more resistance to the water in the tubs. The shafts were about 720 feet deep.

Finally he ran the surface line across the top of the shaft, and marked it by a tack in the collar on each side. After carefully adjusting the side telescope on his transit, he set up his instument on a platform, about 20 feet above the surface and over the center of the shaft, so that the side telescope would revolve in the vertical plane through the tacks. He then swung the line to the bottom of the shaft.

At first he tried to sight at two straight edges, fastened together with a slit about 1/16 inch wide between them, and with lights placed below them. But the lights flared so much that he cut a large hole near each end of the boards, and over each of these placed a plate, with a cross cut in it, and threw a light up through these with a bull's eye lantern. The crosses were then ranged in, and the line between them was used as the base for the underground survey.

The shafts were 5,020 feet apart and he had an error of 3 minutes in angle and of 3 feet laterally, in closing, after the connection was holed through.

In adjusting the instrument, he first made the horizontal axis truly horizontal, by sighting with the main telescope at a long fine wire, adjusting the axis until it followed the wire throughout its length. The wire was suspended from a high trestle and carried a winged bob hung in oil. He then stretched two wires, at a distance apart equal to the distance between telescopes, between the tops of two bu'ldings, and set the instrument directly under one of them, so that the main telescope would travel along it, and then adjusted the side telescope to follow the other wire.

BY PLUMBING.

The transfer of the surface aligument to the mine by plumbing, can only be done where there are vertical shafts. There may be either one shaft or there may be several.

One Shaft.—When there is only one shaft, a line is run across its top, projected to the bottom by plumb-lines, and the line between them there used as a base, from which the underground survey is run. The line across the top is located by the transit, set at some point connected with the surface survey. Planks are fastened across the top of the shaft, and into these two spuds are placed, so that the line from the transit will bisect their eyes. The distance from the transit to the spuds, and the direction of the line through them and the transit, will determine their position. The plumbing wires are now passed through them and lowered by 1 or 2 pound iron bobs to the bottom, where 20 to 30 pound ones are substituted, and hung in tubs. After the wires have stretched all they will, and the bobs have been raised so as not to touch the bottom, the tubs are filled with water to decrease the vibrations, and then a cover with a hole for the wire to swing through, is placed over them to prevent anything from falling in to disturb the water.

Sometimes the water in the tub is covered with oil to quiet the waves and sometimes a thin oil, like signal oil, is used instead of water and at other times thick oil, brine, molasses and even mud and water have been used, according to the fancy of the engineer or to the materials available, the thicker fluids being used to increase the resistance to the swinging of the bob.

The wires must be examined to see that they hang clear throughout the entire depth of the shaft and must be protected from lateral air-currents at the different levels. In plumbing for the Mersey Tunnel they tested the wires with an electric current to see if they touched anywhere. The common method is to have a man at one end of the wire pass a light around it very slowly and have an observer at the other end notice whether he can see it at all times, as he should be able to if the wire does not touch. The distance between the wires should be measured at the bottom to see that it is the same as at the top as an additional check on their hanging freely.

When the wires are all right, the transit is set-up, under-ground, in the prolongation of the line through the two wires. By setting far enough away both wires can be seen without changing the focus. The approximate position for the transit can be determined by passing a light cord just tangent to the two wires, or by ranging a plumb-line in line with them. Several trials will give a mark very nearly right. The transit can then be set over this, and the final setting made by

* Begun in March, 1895.

† Proof is given by Prof. F. L. Vinton in article "On an Eccentric Theodolite" Am. Inst. of Mining Eng. Vol. 1 p. 63.

* "Mine Surveying" by Suter and Munroe. School of Mines Quarterly Vol. 3 p. 269. Give four methods of surveying shafts.

† Engineering—London, Jan. 20, 1882, p. 48. Abstract in article on "Mine Surveying," by Suter & Monroe School of Mines Quarterly, Vol. 3., p. 269.

* "Survey of Underground Connections at Leavenworth, Kan.," by E. A. Sperry, Trans. Am. Inst. of Mining Eng., Feb., 1894.

shifting the tripod head, until the two wires appear directly behind each other on sighting through the telescope. The line can now be transferred to the roof or floor, and marked by permanent points, far enough apart to give a good base line. The direction of the line through them will be the same as the original line carried across the top of the shaft and their distances from the plumb-lines will complete their horizontal location, and the wires may be removed. The elevation of points under-ground are determined by measuring the depth of the shaft.

In sighting at the wires they may be made visible by holding a piece of paper behind them, and illuminating it with a light in front of it or by one behind it.

Where the bobs will not settle on account of air currents or dropping water, it is necessary to bisect the swings of the wires. If the vibrations are small they can be bisected by the eye in sighting at them, but if the wire swings outside the field of the telescope, it can be followed with the telescope to its extreme position, then read the vernier quickly, and follow it to the other extreme, read the vernier again. The center position of the wire will be the mean of the two reading, this should be repeated several times until a good mean position is determined.

As shaft plumbing is only needed occasionally and as the apparatus is simple, the necessary things are usually improvised by the engineer to fit his special conditions. It will therefore be profitable to describe the methods used by different persons, as some combination of them or method suggested by them may aid some engineneer in solving his problem.

There are several schemes for determining the exact central position of the swinging wire.

Prof. Schmidt of the Frieberg School of Mines, determined the middle point of the swings, by means of a finely graduated scale placed behind each wire, and perpendicular to the line of sight. The extremes of the swings were noted, and by bisecting them the central position was found. A number of observations were made and the mean positions were used. The bobs weighed 50 pounds and the wire was 1/25-inch in diameter. The scale was illumined by the ordinary miner's lamp.

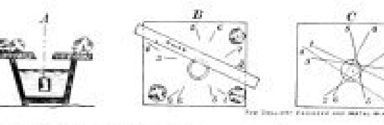


FIG. 14.—TUB FOR SHAFT PLUMBING. *A*, ELEVATION; *B*, PLAN OF TOP; *C*, FINDING THE POINT.

Prof. Schmidt also invented a clamp for holding the wire when its position was to be observed at several levels.

He arranged a cast iron frame, through which the plumb wire hung, and which carried two scales, which could be set so as to be perpendicular to two lines of sight, one from the transit and the other from a second telescope placed at about right angles to the transit. The position of the wire was thus determined in two directions. The bob was then removed, and the wire fastened to a center block, which was shifted by screws in the frame until the wire stood in the central position as determined by the two telescopes. With the wires thus stretched, observations could be made on them at any number of levels.

Another way to get the true position of a swinging plumb wire is to cover the tub in which the bob hangs with a board in which a round hole several inches in diameter is cut conically, Fig. 14—*A*. The cover must be well anchored. Then, as the wire swings to and fro, a rule is placed at right angles to the direction of the swing, Fig. 14—*B*, and kept just ahead of the wire, so that its extreme position can be noted by marks made at each end of the rule, and both numbered alike. This is repeated until a number of marks have been made. The bob is then removed and a plug placed in the hole, Fig. 14—*C*. The lines are now drawn across the top of the plug and a circle drawn tangent to as many of the lines as possible. The center of the circle will be the central position of the wire. Irregularities in the swings will give circles with other centers, but these can be neglected and the point chosen as the central one which has the burden of the proof in its favor. A pin can be placed on the central point when found and used to sight at.

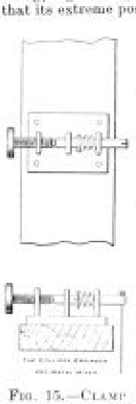


FIG. 15.—CLAMP FOR WIRES.

In plumbing shafts in Montana, from 1,000 to 2,000 feet deep, * Mr. L. Kuhn hung the wires in a single compartment of the shaft. This gave him a base only 3 feet long, but still he checked his surveys within 3 inches. In placing the wires in line at the top, a plumbing board was fastened across the shaft, and the two wires were each attached to a movable support, clamped to it. Each support, Fig. 15, consisted of an iron rod, sliding in two upright pieces. The rod had a groove at the outer end for holding the wire, and the other end was seated against a set screw, and held there by a spring. These allowed the wires to be moved until they were exactly in the desired line. He used No. 22 copper wire, let it down with a one-pound bob, and finally stretched it with a 10-pound one, swinging in a bucket of water covered with an inch of black oil. In communicating with the man at the top, to raise lower or stop, the regular mine signals for hoisting were used.

To facilitate the work of sighting at the bottom, the further wire, from the instrument, was illuminated, while the near one was made to appear, as a dark line on light ground, by placing a light between the two wires and close to the back one, Fig. 16. The light was provided with a reflector, which increased the light on the back wire, and also kept it out of the transit. The base was made two inches wider than the screen and painted white, then by setting it a little to one side, the near wire appeared on this white base as a dark line.

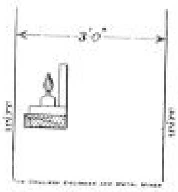


Fig. 16.—LIGHT AND REFLECTOR FOR ILLUMINATING WIRES.

(TO BE CONTINUED.)

* "Transferring Surface Alignment Underground" L. Kuhn, Eng. & Min. Jour. Vol. LV p 179 Feb. 25, 1893.

MINE HAULAGE.

Description of a Compressed Air Mine Locomotive.

The Susquehanna Coal Co. has just put at work in No. 6 shaft, at Glen Lyon, Luzerne county Pa., a compressed air mine locomotive built by Messrs. H. K. Porter & Co. of Pittsburg, Pa., and two other leading anthracite mining companies have ordered similar locomotives.

These locomotives are for use in mines where the liability of the presence of explosive gas is such that steam or ordinary electric locomotives might prove dangerous.

Though the current of air forced through the mine workings is large enough to dilute and carry off the gas in a non-explosive state, the managers of the three companies decided to make assurance doubly sure by the use of locomotives that would neither require a fire under the boiler, or a trolley that might emit sparks in case of a sudden accumulation of gas due to some unforseen accident. While this was a potent factor in deciding on the use of the compressed air locomotive, the question of cost and expense of operation was also considered and found to compare very favorably with those of any other system of haulage, and indirectly to be more more favorable than most others.

In the accompanying illustrations Fig. 1 shows a side view of the locomotive, Fig. 2 shows one end view, and Fig. 3 shows the other end view. Naturally, in mine work, the front will as much as possible, be that end shown in Fig. 3.

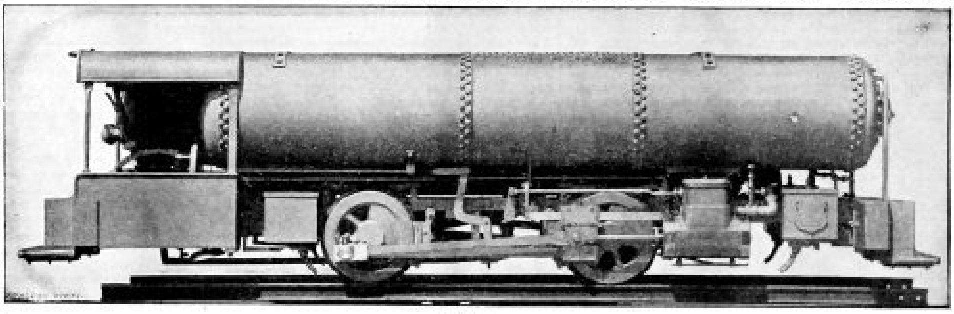


FIG. 1.

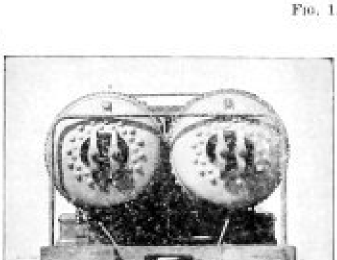


FIG. 2.

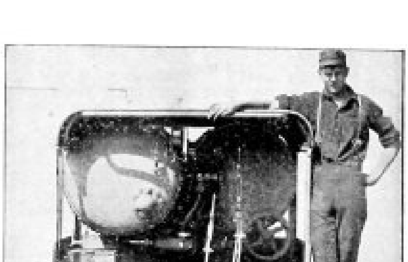


FIG. 3.

A description of the locomotive installed at Glen Lyon is as follows:

It is 17 ft. 6¼ in. long, 5 ft. 2 in. wide and 5 ft. high. It weighs 18,500 lbs. Its working pressure is 600 lbs. The cylinders are 7 in. x 14 in., and there are 4 steel-tired driving wheels each 24 in. in diameter. There are two air-tanks as shown in Figs. 2 and 3. They have a total capacity of 130 cubic feet, with an auxiliary reservoir and reducing valve for delivering the air to the cylinders at 100 to 140 lbs. pressure, which can be varied instantly as desired. The tank heads are convex, and are double riveted with manholes in the end shown in Fig. 2. The horizontal seams of the air-tanks are triple riveted, and an abundant factor of safety has been provided, having been tested tight with 900 lbs. pressure.

The four driving wheels have a powerful hand screw brake attached to each. The tanks, tires, axles, crank pins, rods, cross-heads, guides and links are all made of steel, and there are hardened removable bushings and pins used throughout all valve gear. Sand boxes to sand all the wheels, when running in either direction are provided.

All the operating levers, valves, etc. are in easy reach and under the constant control of the engineer.

The locomotive is specially constructed throughout all its details to secure the best efficiency, utmost convenience and uninterrupted work for long hours under severe conditions. The few repairs necessary can, owing to the construction, be made easily and quickly.

The locomotive in this case runs over a track of 36 in. gauge. There are no excessive grades or very sharp curves, though the machine is designed to overcome such conditions if they did exist.

As was implied before, it is impossible in many mines to use a steam locomotive on account of the danger from fire and sparks and the difficulty of removing smoke from the openings. The compressed air engine, while entirely free from these objections, really aids ventilation to some extent, the exhaust from the cylinders furnishing an appreciable addition to the supply of pure air in the galleries. The advocates of this system claim that it has many advantages also as compared with the electric motor, and these claims may be stated as follows: In the first place, no wires are required, and there are no obstructions overhead or underneath the entry, but the tunnel is left entirely free and clear. In the second place, the power is self-contained, and as long as there is a supply of air in the tanks the engine can move, and is not disabled by any breakage in connecting wires. Thirdly, the engine can be used at will in any entry where a track has been laid, and is not dependent upon wire connections. Again, the only machinery required is the air compressor, with which many coal mines are provided. The operation of filling the tanks is extremely simple, and has to be repeated only at considerable intervals.

While this locomotive is a new feature in the Wyoming region it is by no means an experiment. Two or three years ago we published a description of a similar locomotive built by Messrs. Porter & Co., for use in a mine on the Monongahela river, and it was this description that attracted the attention of Major I. A. Stearns, Gen'l. Supt. of the Susquehanna Coal Co., and the officials of the other two companies, to compressed air locomotives for use in mines where other mechanical haulage devices would not be practicable. Messrs. H. K. Porter and Co., have built a number of these locomotives for mine use, and in every instance they have proven efficient, safe and economical. The same firm has also designed compressed air motors for street cars, which they claim are free from the faults of trolley cars, and are far more reliable than storage battery motors, which so far have only reached the experimental stage.

We note that the Taylor Iron & Steel Company, of High Bridge, N. J., have recently installed the C. W. Hunt Company system of cars and track for handling their material, also that the Otis Company of Ware, Mass., have again added to their already very complete system of Hunt industrial railways.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following question for solution in your next issue.

I have a pair of parallel entries between which I have seven break-throughs and my entries are driven in 35 yards past the inside break-through. Break-throughs No. 6 and No. 7 are so that you can close them in a minutes notice. Now, there is a shot fired in my return entry. What I want to know is this: Will the smoke leave quicker by closing No. 6 break-through and leaving No. 7 open, or will it leave quicker by closing No. 7 for five minutes and opening No. 6, then, closing No. 6 and opening No. 7, changing continuously until the smoke has gone.

Yours etc.,
Elco, Wash. Co., Pa. HUGH CAIRNS.

Expansion and Contraction of Air.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following question in your valuable paper for some of the readers to answer.

As air expands $\frac{1}{491}$ for every degree of heat and shrinks or contracts $\frac{1}{459}$ for every degree below zero. Now, suppose the law of contraction holds and we fix the temperature at 459° below zero, what will become of the air and its weight?

Yours etc.,
E. Palestine, O. R. T. DAVIS.

Ventilation and Arithmetic.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following in your valuable paper in answer to query given by A. McDonald, Port Morien, in your August, 1895 issue.

(1.) What would be the area of an airway to pass 50,000 cubic feet of air per minute if 20,000 cubic feet is passing through one 5′ x 4′ or 20 feet area.

We will suppose the pressure and also the form of the airway to remain the same, then, by the following rule: Take $\frac{2}{5}$ root of the ratio of the quantities of air and multiply this by the given height, which will give the height of required airway, then multiply the $\frac{2}{5}$ root of the ratio of the quantities by the given breadth, which will give the breadth of airway required. The ratio of the quantities will be $\frac{50,000}{20,000} = 2.5$ then $(2.5)^{\frac{2}{5}} = 1.4427$ and $1.4427 \times 4 = 5.77$ feet, the height of airway required. Then $1.4427 \times 5 = 7.21$ feet, the breadth of airway required, and $7.21 \times 5.77 = 41.6$ sq. ft. the area of airway required for 50,000 cu. ft. per minute.

(2.) What is understood by the formula $(3)^{\frac{2}{5}}$? Work out and explain.

The formula $(3)^{\frac{2}{5}}$ means to extract the $\frac{2}{5}$ root of 3 and can be easily solved by logarithms as follows. You will find in a table of logarithms the log. of 3 to be .477121 and to obtain the $\frac{2}{5}$ root of any number, multiply the log. of the member by 2 and divide by 5 thus: log. 3 = .477121 and $\frac{.477121 \times 2}{5} = .190848$. The number corresponding to log. .190848 is 1.5518 +.

Yours etc.,
Scammon, Kans. J. G. WILLIAMSON.

ANS. 1. We will assume that the pressure is the same for both airways.

For small airway $p = \frac{k\,l\,p\,a\,v^2}{a}$ (1).

Now, as the ratio of the dimensions of the large airway, is not given, we will suppose it to be square.

Let x = length of one side of large airway.
Then $4x$ = perimeter.
And x^2 = area.

Whence $p = \dfrac{k\,l\,4\,x\left(\frac{q}{x^2}\right)^2}{x^2}$ (2).

From (1) and (2) $\dfrac{k\,l\,o\,v^2}{a} = \dfrac{k\,l\,4\,x\left(\frac{q}{x^2}\right)^2}{x^2}$ (3).

Now, dividing (3) by k l, and substituting known values, it becomes

$$\frac{18 \times (1{,}000)^2}{20} = \frac{4x\left(\frac{50{,}000}{x^2}\right)^2}{x^2}$$

Simplifying and transposing

$$x^5 = \frac{10{,}000{,}000{,}000}{900{,}000} = \frac{100{,}000}{9} = 11{,}111.11.$$

Therefore $x = \sqrt[5]{11{,}111.11} = 6.444$
$x^2 = 41.525$ = area required.

Yours etc.,
Houtzdale, Pa., Aug. 6, 1895. ADOLPHE COOK.

1. ANS. $\frac{50{,}000}{20{,}000} = 2.5$.

$\sqrt[5]{2.5^2} = 1.4427$.

$(1.4427 \times 5) \times (1.4427 \times 4) = 41.627$ + area of airway required.

Assume length of airway as 1,000 feet and the well-known formula $p = \frac{k\,s\,v^2}{a}$ will prove p equal in each airway.

2. ANS. $(3)^{\frac{2}{5}}$ equals $\sqrt[5]{3^2}$ or the fifth root of 3 squared. $3^2 = 9$ $\sqrt[5]{9}$ is found by logarithmic tables.

Thus, Log. 9 = .9542425.

$\frac{.9542425}{5} = .1908485$.

.1908485 = Log. of 1.55184.

Therefore $\sqrt[5]{3^2} = 1.55184$.

Yours etc.,
Victoria Mines, C. B., Aug. 8, 1895. T. J. B.

(2). What is understood by the formula $(3)^{\frac{2}{5}}$? This means that 3 is to be raised to the $\frac{2}{5}$, or what is the same, to the .4 power. This will require the application of logarithms, and the following is the rule.

(1). Find the logarithm of the number and multiply it by the exponent of the power, and the product will be the logarithm of the power.

(2). Find the number corresponding which will be the power. Consulting a table of logarithms we find:

Log. 3 = 0.47712. $0.47712 \times .4$ = Log. 0.19085.
Number corresponding to Log. 0.19085 = 1.5518 +.

Yours, etc.,
Rock, W. Va., Aug. 15, 1895. E. W. BAILEY.

To Extract the 5th Root by Arithmetic.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following in answer to A. McDonald, of Port Morien.

QUES. What is understood by the formula $(3)^{\frac{2}{5}}$? Work out and explain.

ANS. It is a mathematical expression, meaning the 5th root of the square of 3, sometimes written thus $\sqrt[5]{(3)^2} = \sqrt[5]{9}$. The extraction of roots by logarithms is easy, but there are no helps (*and rightly too*) at examinations. By the following method any root may be extracted. You will observe there are four columns. There is always one column less than the root to be extracted. The operation is as follows:

Col. 1.	Col. 2.	Col. 3.	Col. 4.	
1 1	1 2	1 3	1 4	$\sqrt[5]{9} = 1.55184$ 1
2 1	3 3	4 6	50000 81875	800000 679375
3 1	6 4	10000 6375	131875 121250	14062500000 13528[illegible]875
4 1	1000 275	16375 7875	2531250000 174469375	533901[illegible]0000 28887294012751
55 5	1275 300	24250 9500	2705719375 180283730	244950[illegible]0000 2295[illegible]8
60 5	1575 325	33750000 1140875	288600312'0000 87262782751	12314[illegible]0000 1159[illegible]424
65 5	1900 350	34890875 1162875	2886729[illegible] 87286823254	716697[illegible]
70 5	225000 3775	36053750 1182000	2895[illegible]0000 2784[illegible]	
755 5	228775 3800	37235750000 24002751	2906441[illegible] 2957[illegible]184	
760 5	232575 3825	37262782751 24040568	2909[illegible]0000 1491782[illegible]1856	
765 5	236400 3850	37286823254 24048256	290[illegible]1856	
770 5	24025000 7751	37310871510000 19249771712		
7751 1	24032751 7752	37330121281712 192[illegible]35936		
7752 1	24040503 7753	37349[illegible]7648 19250700672		
7753 1	24048256 7754	37368[illegible]20000 963245710464		
7754 1	2405601000 620464	3739[illegible]464		
77558 8	2406221464 620528			
77566 8	2406841992 62[illegible]592			
77574 8	240746[illegible]84 62[illegible]6			
77582 8	240808[illegible]000 3103[illegible]			
775901	24081142701[illegible]			

Point off the given number into periods of five figures each. The first period may contain from one to five figures. Find root figure of first period, place it to the right as a quotient in division, also place it in first column. Multiply it by root and place in 2nd column, multiply it by root and place in 3rd column, multiply by same figure, place in 4th column, multiplying by same root figure, place product under first period and subtract it from same. Bring down next period, next add root figure to figure in first column, multiply this sum by root figure just found, add to second column, multiply sum by root figure, place in third column, multiply sum of third column by root figure, place in fourth column. Now annex four ciphers to fourth column and again add root figure to first column; continue as above, then annex three ciphers to third column, add root figure again to first column, multiply it again, add to second column and annex two ciphers to second column, add root figure to first column. The figure in first column will now be five times root figure, find next root figure from column four and place in quotient, also place it in first column to the right of figure or figures there, thus increasing the number ten times, the new root figure being in units place to right of that already there. Proceed in same way throughout. The example will help explain.

Yours, etc.,
ROBERT HINNING,
Carterville, Ill.

Magnetic Attraction of Iron Ores.

Editor Colliery Engineer and Metal Miner:

SIR:—In the July number I read some considerations on the magnetic power of iron ores.

To complete the knowledge on the matter I can tell you that it is true that many iron ores have no action on the magnetic needle, but this is not a sufficient proof of its diamagnetism.

To ascertain the magnetic power of iron ore, it is necessary to reduce it to a very thin powder and put it in a little pipe of paper 4 inches long and ¼″ in diameter. The ore must be compressed in the pipe as much as possible.

When this pipe is suspended with a thin thread, if you approach a strong magnet with it, the extremity of the pipe is attracted.

I have made such an experiment with the ores of our mine which have no practical influence on the compass when in place, but are very little magnetic if experimented as described.

Yours etc.,
Orbetello, Italy, July 28th, 1895. UGO BAGNOLI.

Mischievous Mine Legislation.

Editor Colliery Engineer and Metal Miner:

SIR:—In the May issue of this Journal I was allowed the privilege of commenting on an undeniable case of Mischievous Mine Legislation, viz: the recent alteration of Section 2, Article 15 of the bituminous mine law of Western Pennsylvania.

As a victim of this particular clause, I claimed the right to protest against it, and only asked an opportunity to attempt to confute whatever arguments had been advanced in its favor, and to prove the evil influence exerted by a few apparently harmless words. In order to test the validity of the arguments that had been used to effect this change, I offered to discuss the subject with the gentleman who had introduced it, but he has not deigned to reply. Had he accepted my offer and been able to demonstrate that it was essential to the welfare of the coal diggers and ordinary mine workers, or a benefit to the coal operators subject to its jurisdiction, if he could successfully combat any of the comprehensive articles that occasionally appear in this paper against similar cases of illconsidered laws, or if he could have shown any of the arguments I proposed to bring against it to be erroneous, I would have been forced to admit that my objection was groundless.

Owing to the silence of the aforesaid gentleman, I can only appeal to the gentlemen who inadvertently supported this measure to reconstruct this clause so that any reputable American citizen having the requisite experience in bituminous mines—either at home or abroad—may be legally entitled to compete at any examination for a certificate as a mine official.

The clause in question virtually declares that a miner is incompetent to manage a coal mine in this State unless he has had five years' local experience. This is not only a harsh and unwarranted commentary against the capability of every miner outside of Pennsylvania, but it is unjust, seeing that experienced miners from Pennsylvania are eligible as mine foremen in almost every part of the United States, whereas this ridiculous clause effectually prevents Pennsylvania from granting similar privileges to American miners from other coal fields, thereby gaining the questionable distinction of being one of the few states in the Union where a certain section of the American people are treated as foreigners.

Will this prohibition of competent miners from other mining districts increase the efficiency of Pennsylvania mine officials? Is it likely that a better class of mine foremen can be selected from a comparatively small area (Pennsylvania) than from a large one (the United States) or is it assumed that there are no capable miners except those having five or more years' experience in the mines of Pennsylvania?

As a direct result of this clause in its present form, an American miner from any other state, who, by force of circumstances, is induced to follow his occupation here, must surrender for a term five years, the rights and privileges of American citizenship that are generally supposed to be inalienable. Surely it is not a criminal act for a workman to move from one state to another, yet if the immigrant is a coal miner with a laudable desire to improve his condition, and Western Pennsylvania is his objective point, this mischievous clause determines the penalty for such an act to be disfranchisement. If this law had been in operation a few years ago, some of the leading mine officials of this State—men who have given undeniable evidence of their ability to succeed in any position connected with this industry—would most certainly have been kept out of the State. If the mining authorities of other states were foolish enough to adopt a law similar to this one, American miners could not be truthfully classed as American citizens, they would become citizens of Ohio, Indiana, or any other coal mining state, but not citizens of the United States, not American citizens.

By a slight contraction of the "Scientific Frontier," defined by this clause, a miner qualified to act as a mine foreman in the Pittsburgh district, would be prevented from holding a like position in the Connellsville district, and vice versa, men who would be considered competent officials in one county could not lawfully perform similar duties in an adjacent county. Contract it again and it might eventually be illegal for a mine foreman in Mansfield to be engaged for, or to accept a position as mine foreman at "Saw Mill Run," or a man might be considered a trusty official in the vicinity of Dunbar, yet it would be unlawful to employ him as an official in the neighborhood of Uniontown, the only difference between the assumed and the actual line of demarkation being a question of extent.

Amend the mine laws by all means, raise the intellectual standard of mine formen either by making periodical examination compulsory—similar to the mine inspectors—or by any other method that will offer an incentive to them to study the theory of mining, and thus enable them to cope with unexpected dangers, but in the name of common sense and justice, do not make laws, nor allow those already made to remain on the statute books of Pennsylvania, that will boycott experienced miners, and American citizens, because they may have had the misfortune (?) to be trained in other coal mining districts, and probably under conditions more difficult and dangerous than are usually found in the coal mines of Western Pennsylvania.

Yours etc.,

Allegheny, Pa., Aug. 7th 1895. EDWARD HALPIN.

Why Theory has a bad repute among many Practica Men.

Editor Colliery Engineer and Metal Miner:

SIR:—I noticed in your issue of December, 1894, page 109, this sentence. "There is mistaken idea among many miners that theory is a bugbear that they must avoid at all hazards." As a miner I would like to give a few reasons why this idea exists. In the past, and until quite recently, nearly all mining literature was written in language that was unintelligible to the average miner and some of it was written by men with limited practical experience, which often resulted in giving the miner a sort of a "Gullivers Travels," description of his every day occupation. I recently read a book written and published in Pennsylvania about forty years ago; the author after complimenting the miners as being the most ignorant class of workingmen, devotes several pages to describing a mattock, a tool used to cut clay with and finishes with a rather positive statement that the gold discoveries which had been and were being made in California at that time would soon be exhausted, and that Georgia was about the only State which might be expected to furnish a regular and permanent supply of gold. About fourteen years ago one of the most prominent of M. E's., C. E's., E. E's. and all other E's. combined, wrote a series of articles to the *Mining Journal*, London, Eng., from San Francisco, informing us miners that we need not expect to find much gold outside of California or Australia, still later a theoretical M. E. asserted that the Anaconda of this place was no mine but simply a hole in the ground. This mine is one of the largest and richest that was ever known, it is down 1000 feet with good ore on the bottom, and the ore body in some places is over one hundred feet wide.

A theorist who had charge of some very important operations connected with copper mining in Montana, ridiculed the statement made by miners that some of our copper ores carried large quantities of silver.

Such incidents as these tend to destroy all respect that a miner might have for theory as it is written.

Further, miners as a class are great travelers, they know of different methods used at different places to accomplish the same object, they tell each other of the different methods, argue vigorously in favor of their own local custom, but generally adopt the method or modification which is really the best, they have a good deal of theory of their own which, perhaps, is not as scientific as it might be, but most of them can apply it practically as they understand it. By the term miner I mean those men who have worked underground from childhood, who would rather work there than on surface, many of them are fond of collecting specimens of some of those beautiful fern fronds, and other fossil impressions so frequently to be found in some strata in and about the minerals in which they are working, and some have formed opinions of their own respecting the manner of deposition of veins etc. I exclude the ice cream and banana peddlers found working in the easten coal mines, and also the railroaders, woodchoppers, rfarmers and teamsters that are very numerous in the western mines, with their established rate of wages, which makes all underground workers, miners.

Yours etc.,

Butte, Montana. STEPHEN H. NORTHEY.

The C. W. Hunt Co's. new catalogue entitled "Industrial Railways" is a beautiful production, and contains many useful hints for users of industrial or mine tracks. It is sent free on application to the C. W. Hunt Co., 45 Broadway, N. Y.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for September.

QUES. 175. There is at present a ready market and a good price for fire-bricks; flooring tiles for fire-proof buildings; common bricks for filling and backing; glazed and unglazed facing bricks; sewer pipes and drain traps.

Our Coal Mining Company wish to share in this manufacture and trade, and have desired me to make sample bricks out of the underclays of five different coal seams we are working. I have done so with the following results: Clay of seam *A* makes a hard strong red brick coarse in the grain; Clay of seam *B* contains iron balls, but the dressed clay makes a soft white brick that is very porous; clay of seam *C* makes a soft white brick that is very porous and speckled with blackish brown spots; clay of seam *D* makes a hard coarse grained brick, and of a black and bluish color; clay of seam *E* makes a white brick that is very strong and fine in the grain. Now I desire to know two things to enable me to make a satisfactory report to the company.

First. What classes of goods are each of the clays best adapted for making?

Second. What are the constituents in the clays that give to the bricks their different characteristics?

QUES. 176. Here are two samples of bituminous coals, and in chemical composition they are both alike, and even make cokes that are alike, after they have been ground small and steeped in hot water. Hot water disolves out of sample *A*, nitre, and out of sample *B*, common salt, and what I want to know is this, what effect will nitre have on the coking of sample *A*, and what effect will common salt have on the coking of sample *B*.

QUES. 177. We have a bituminous seam of coal at a depth of 400 feet and lying nearly level, and we are going to work it by the system of longwall retreating. The floor is a soft shale and the roof is a slate. We will be obliged if you will give us a map of the best plan of working, together with all the necessary explanation.

QUES. 178. We find the roof of a coal seam we are working is an argillaceous lime stone, and what our neighbors call the same seam in the surrounding collieries has in some cases a slate roof, in others a sandstone roof and in others an arenaceous limestone roof. Do you think it is the same seam of coal in all the cases, and if it is, under which kind of roof will the coal be thickest?

QUES. 179. I am now a fire-boss but I am promised promotion if I can learn to level, will you therefore show me with a sketch and an explanation how to level upgrade for 25 yards? Make the surface very uneven, and after setting up the instrument read the staff every five yards.

QUES. 180. The action of one of our mine pumps is very peculiar, and it will startle you when I tell you, that any increase above a certain speed of the piston reduces the lifting power of the pump, and at another increase of speed the pump looses the water altogether. Now as I would like you to explain the tricks of this peculiar pump I will give some particulars. When the pump piston is at the bottom of its stroke, it is 12 feet above the level of the supply water, and as the force to lift the keep valve and overcome the friction of the water moving through the tail of the pump is equal to a two-feet column of water, we may reckon the mean lift to be 14 feet. Will you then tell me two things.

First. What is the highest speed at which this pump can be run to obtain a maximum effect?

Second. At what piston speed does the pump loose the water altogether.

Solutions to Questions which Appeared in the July Number, and for which Prizes Have Been Awarded.

152. There is a shell-fish that is commonly found on the sea beach near the mouths of rivers and it is best known as "the *mussel*." This fish is a bi-valve, and strange to say, a bi-valve exactly like it is frequently found in great numbers, and closely compacted in masses, in the blue or black shales that overlie some of the coal seams, and stranger still, the miners often call the fossils "stone mussels."

There can be no doubt that the bi-valve of the Carboniferous period belonged to a family closely allied to the representatives of the mussel families that live in our seas to-day. Will you then be good enough to let me know the period during which this bi-valve made its first appearance, and also the different names it is known by in all the succeeding formations up to the most recent, including those now living on the ocean shore.

ANS. Representatives of the Mytilidae are first encountered in the Tremadoc slates (British classification), and in the Trenton period of the Silurian (U. S.).

Mytilus is found from the Silurian to the present time. This genus is represented by 100 fossil and 65 existing species.

Myalina is found from the Carboniferous to the Permian—there becoming extinct.

Modiola is found from the Silurian to the present time—and the same may be said of the sub-genus Modiolopsis.

The following are some of the species found as we ascend the paleontological scale.

Modiolopsis carinata—Trenton period, M. Subrhomboidea—Niagara period.

Mytilarca occidentalis—Chemung period.

Modiola metella—Chemung—Catskill period.

M. Augusta—Catskill period.

Myalina recurvirostris—Coal measures.

The following are some of the modern representatives of this family:—

Mytilus edulis, M. latus, M. canaliculatus, M. magellanicus; Modiola modiolus, M. capensis, M. pelagica, M. viator, etc.

WILLIAM R. EVANS,
133 So. Lincoln ave.,
Scranton, P.

Second Prize, JOS. VIRGIN, Hollsopple, Pa.

QUES. 163. The underclay of a coal seam we are working is four feet thick, and the company have requested me to find out if it is good fire-clay, or if it will make good sanitary pipes. I am told that the best way to test it as a fire-clay, is to make three or four bricks and burn them in a furnace of high temperature, when if the bricks contain iron or lime in *excess*, they fuse and "run," and therefore such clay will not make fire-bricks, but the best sanitary pipes can be made of it. Now I would like to make a show in my report and to do so, will you explain to me?

First. Why clay containing an excess of iron or lime fuses?

Second. What is an excess of lime or iron?

Third. Why good fire-clay will not make good sanitary pipes?

ANS. First. When the underclay of a coal seam contains 2 or more per cent. of iron, and 1 or more per cent. of lime or magnesia, at a high temperature, 2,500° F., the silica fuses with the iron and lime of the clay, and vitrifies.

With higher percentages of iron or lime, the fluidity of the glassy fusion increases.

Second. Clay containing an excess of oxide of iron or lime, at a high temperature fuses into true glass, for many oxides of metals, mixed in equal parts by weight with silica, fuse and produce a perfect glass.

Third. A good fire-clay that makes refractory bricks that withstand the temperatures of the hottest furnaces, is too porous and too brittle for the manufacture of sanitary pipes, that ought to have a relatively high tensile and compressive strength.

P. H. CARROLL,
Vivian, W. Va.

Second Prize, S. U. PHILLIPS, Leechburg, Pa.

QUES. 164. We have a coal seam 12 feet thick, with a shale band in the middle of it, 30 inches thick. All the coal is of first rate merchantable quality. The seam is pitching 5 degrees to the east, and the thickness of the cover is 1,200 feet. The roof consists of 5 feet of shale which falls. The floor is very strong. Say how you would work this coal and secure the face, and give good reasons for your conclusions.

ANS. I would drive the entries in the lower seam, and to prevent a jam in obtaining the top seam, I would take down the 30 inches of shale and have the top coal for the roof in the first working. I would advance my rooms to the west, upgrade, and leave good stumps between the rooms which I would make 7 yards wide, and advance them 65 or 70 yards in length.

If possible I would keep up the 5 feet of top slate in the rooms. While coming back with the rib; I would take down the top coal the full width of the room and rib and secure the face of the rib by 1, 2, or 3 rows of posts kept under the top seam, and while drawing the room and entry stumps the top seam could be got as before. This system of working would be the safest for the the miners, and be the most profitable for the operators.

Each pair of entries should be driven in line, before the rooms are turned off.

HUGH CAIRNS,
Eleo, Washington Co., Pa.

Second Prize, THOMAS WEST, Sherrodsville, Carroll Co., O.

QUES. 165. We have got the creep in one of our seams and we have extended it by trying to stop it. An old experienced miner says "that the quickest, cheapest, and surest way to stop the creep is to help it by drawing out all supports, and by weakening the pillars of coal that interfere most with it. Is the old man right or wrong? Please let me know at once, and explain, if you agree with him, why his mode of proceeding is the best.

ANS. The old man is right, and to support his conclusion it is a fact that all seams are subject to creep, that have a strong cover and a soft floor, and without a soft floor the coal may be nipped, but the floor will not lift and creep.

When the floor is soft and the covering rocks are strong, the pillars ought to be large and no coal stumps or undrawn timber ought to be left in the gob. To stop the creep, first proceed to examine a map of the workings, and you will invariably find, that small pillars are not so much the cause of creep, as groups of pillars belonging to unfinished workings, and jutting right out into the gob and preventing the breaking of the covering rocks, these should be worked out as quick as possible, and in the meantime, the pillars skirting along the outside of the locality of the creep should be strengthened by cribbing.

L. A. Garany,
Brookwood, Ala.

Second Prize, Jos. Quigley, Westville, Pictou Co., N. S.

Ques. 166. For an extension of the haulage in a coal seam we are about to make a branch road going due east from the main entry going due north from the shafts. Now the junction of the branch road with the main road has to be done with a curve of 24 feet radius, and as I would like show off a bit with this curve, will you give me a plan showing how to set up the centre lines with chords, and the fewest angular measurements required for a complete quadrant, the curved road being 12 feet wide.

Ans. We are sorry to say that we have not been able to select out of many papers sent in, a satisfactory *practical* answer to this question. No competitor has even attempted to show how to *set up* the center lines.

Editor.

Ques. 167. Show that the flora of the Devonian period was similar, and therefore just antedated the flora of the Carboniferous period, and further show, that the fauna of the Carboniferous period was characterized by the introduction of a class of vertebrates, higher in the life scale than fishes.

Ans. Vascular cryptogams such as equisetinae and lycopodinea are first found in the Silurian formation. Some genera of ferns and conifers, sigillaria and lepidodendrons are first found in the Devonian series, and are found to have continued through the Carboniferous period, but we find each of these examples having their distinguishing characteristic more sharply defined, and more highly developed, in the latter formation. The placoid fishes of the Old Red sandstone or Devonian times, became true saurians in the Carboniferous seas, and are found as the fish lizards of the type enalrosaurs.

R. Evans,
133 So. Lincoln Ave.,
Scranton, Pa.

Second Prize, Jos. Virgin, Hollsopple, Pa.

Ques. 168. We have bought a good second-hand double engine with 20 inch pistons and 3 feet stroke. Our hoisting shaft is 750 feet deep, and we intend to hoist 600 tons in 10 hours, and make the old engine do the work, and for that purpose we are going to set it on the first motion. The mean velocity of the hoisting rope when doing coal-work, has to be 1,600 feet per minute. Will you then oblige me by giving two values. *First.* The steam pressure required.
Second. The weight of coals for each hoist.

Ans. Make the winding drum 12 ft. in diameter, then the revolutions per minute will be $\frac{1600}{12 \times 3.1416} = 42.5$ nearly. Allow for time of running 5 hours, then the weight of coals per hoist will be $\frac{600 \times 750}{5 \times 60 \times 1600} = .94$ tons or 2085.6 pounds.

Let the winding rope weigh 1120 pounds, then add the weight of coal to the weight of rope and we have 3205.5 pounds, and the units of useful work done by the engine per minute will be $3205.5 \times 1600 = 5128800$ Allow the modulus of the machinery to be .8, then $5128800 \div .8 = 6411000$ units of gross work to be done. The pressure of the steam then is

$$\frac{6411000}{20 \times 20 \times 2 \times .7854 \times 3 \times 2 \times 42.5} = 40 \text{ pounds.}$$

First; Steam pressure 40 pound per square inch.

Second; Weight of coals per lift .94 ton or 2085.6 pounds.

Joseph Quigley,
Westville,
Pictou Co., N. S.

Written for The Colliery Engineer and Metal Miner.

A "PRISON" MINE.

A Sketch of Prison Life at an Alabama Mine Worked by Convicts.

Without going into a discussion of the question of the right or wrong in the case of the employment of convict labor in mines, a description of a large mine operated wholly by convict labor may be of some interest to the readers of The Colliery Engineer and Metal Miner, such a mine having recently been visited by one of our representatives.

The mine in question is one of a group of coal mines known as the Pratt Mines, operated by the Tennessee Coal, Iron and Railroad Co., at Pratt City, a few miles from Birmingham, Ala., this particular one being locally known as the "Prison Mine."

The reader who has had his sympathies played upon by would-be philanthropists who in the columns of various so-called *newspapers* have set forth what have seemed to their imaginations to be the wrongs inflicted upon those individuals who have transgressed the rules laid down by society for its protection, commonly called "law," would hardly be prepared in mind for such a state of things as he would find on a visit to this penal institution, and he would probably lose a good deal of sickly sentiment concerning the treatment of prisoners.

The "prison" proper at this mine consists of a collection of frame structures within a stockade comprising dormitories, mess-hall, warden's residence, and hospital. All these are but one story in height, raised two to four feet above the ground, and thoroughly whitewashed within and without. Except for gratings at the windows the buildings might pass for whitewashed barns rather than for places for the confinement of criminals.

No cells for isolation of prisoners from each other are used. The men sleep in four large dormitories, 100 to 150 in each, in comfortable beds, and none of the ordinary prison discipline compelling non-intercourse between the men is seen.

The rooms are well aired and ventilated. There are ample though not the most lavishly appointed water-closet accommodations, and the sanitary condition of these is good. No odors come from these closets and they are regularly and thoroughly flushed by ample flow of water.

The hospital accommodations, while not necessarily large, owing to the excellent situation of the place, are ample for the needs of the convicts and a surgeon and physician is in regular attendance.

So much for the quarters of the men. Their "accommodations" in the mine proper will now be described.

The workings proper do not differ materially from others of their class, other than in the provision for bathing accommodations for the prisoners presently to be described. In a big room near the foot of the shaft are a large number of wooden tubs amply supplied with hot and cold waters and soap. In an adjacent room are racks with numbers which serve the purpose of lockers. This part of the equipment is not furnished as a privilege to the miners, but its use is imposed upon them as a necessity every day before they leave the mine.

Each man on entering his term of service at the mine, if his work is to be underground, is furnished a suit of coarse white duck, consisting of a blouse and pair of trousers, in addition to his regulation suit of prison "stripes." The latter is not worn at his work, nor can the former be worn above ground in the prison proper. On entering the mine in the morning each convict wears his "stripes" until he reaches the locker room, above referred to, where he exchanges this suit for his duck suit left there the previous night, and goes to work in the latter named clothing. On leaving the mine at night he first goes to the bathroom described, where, after a thorough wash in hot water he dons his "stripes" to go above ground, leaving, as just noted, his working suit in the locker room. By this system the sanitary condition of the convicts clothing is kept much better than it could be were the same to be worn in the mine and out.

At the time of our visit some 600 names were on the prison register. Of these nearly all were negroes, very few white men being sent to the mines to work. Such whites as were there were all working on the surface, it evidently not being conducive to good feeling on the part of either party to work white men and negroes side by side.

Many of the prisoners who are known as "trustys" are worked above ground as teamsters, tipplemen, gate tenders, cooks, and in whatever positions they can fill. These men, of course, all wear the regulation prison garb of "stripes."

As noted above, no attempt is made to prevent communication between prisoners. In fact, it may be said that sociability and entertainment of each other is the rule of the place, for at intervals regular jollifications are had. The large space with the iron floor at the foot of the shaft is utilized as a dancing pavilion, and various sorts of pleasure gatherings are had here. The natural musical proclivities of the negro stand him in good stead at these times, and the affairs are not infrequently considerably on the minstrel show order, furnishing amusement and entertainment to all present.

These little social affairs do much to brighten the lives of the convicts. One of the officials related how one versatile and genial negro who had been sentenced to a long term of service for stealing a pair of pantaloons, used to put everybody within hearing of his voice in a good humor by his keen wit and entertaining songs.

The labor imposed upon the convicts is not severe. The men are classified, according to their physical condition and experience, into four grades, and to each is assigned a certain "stint" per day. These grades and their respective allotment of work are as follows:

Able-bodied, experienced men, 4 tons of coal per day; a second grade, 3 tons; a third class of 2 tons; and a fourth class of less than 2 tons each. Once a month State officials of the prison department visit the place and make a thorough examination to see that the convicts are being properly cared for in every way.

It takes but a little reflection to discern that it is no less to the interest of the company operating the mine with this class of labor to keep the men in good physical condition than to the State itself. It is a matter of honor and humanity with the State; it is both of these and the further matter of business with the company. For, if the men are not kept in good health and physical vigor, the work per man is correspondingly lessened, while the cost of keeping is increased. Hospital treatment and special diet for convicts with cessation of work is not conducive to profit from the mine.

It should be stated here, perhaps, that no men who can be termed old, or physically infirm, are sent to the mines at all.

Owing to lack of skill and to the natural disposition of convict labor, as a class, to shirk if it can, there is little direct profit in the use of this class of labor, it is asserted by the company officials. In fact, they go so far as to say that with skilled "free" miners they could operate the mine at less cost than it is done now. There is an indirect advantage, however, in the employment of this class of labor, that it is not affected by labor agitation, going on without interruption from strikes, thereby ensuring shipments of coal when other mines may be shut down.

There is some incentive held out to the men to become skilled miners, for to all those who mine over the highest quantity above named as a day's work, 4 tons, the same pay per ton is given in cash to the miner as is paid the free miner in the adjoining mines, though this is something few make any effort to accomplish.

The mine is operated by a shaft. It communicate with an adjoining mine, so ample egress is afforded in case of accident to the shaft or hoisting equipment. This shaft is without the prison enclosure proper, but communicates with it by means of a narrow lane between two high fences well protected by guards stationed at intervals. This will soon be changed, however, as a slope is now being driven directly from a central point in the mine to the prison yard. The slope when completed will effect three important objects; it will give another means of egress from the mine, it will avoid any long exposure of the men in stormy or cold weather, and it will materially lessen the chances of escape of prisoners.

In closing, acknowledgement must be made of the courtesies shown by the Tennessee Coal, Iron and Railroad Co., through its officials, Chief Engineer Ramsay, Asst. Engineer Riley, Mine-Boss Haley, and the Warden of the prison. The trip through the mine was made with State Mine Inspector Hillhouse and a small party of Birmingham friends and every facility was accorded to gain information concerning the system of working with convict labor. Nothing was hidden, nor did there appear to be any occasion for withholding information. The trip concluded with a lunch and refreshment at the warden's house which were appreciated by all.

Coal Mining in the Transvaal, South Africa.

The *South African Mining Journal* gives the following account of the mines of the Transvaal Coal Trust, located 16 miles east from Johannesburg. The mine is developed by the "Old" and "New" main shafts: "The old main shaft is no longer used for development purposes, but the pumping and electrical plant is placed there, and the workings are drained to a large reservoir excavated in the neighborhood of the shaft. This has a capacity of about 1,000,000 gal. The mine makes about 85,000 gal. a day. A Cameron steam pump, with a capacity of 24,000 gal. per hour, is in use and can easily cope with the water made, even in wet seasons. An Evans' Cornish pump of 16,000 gal. is kept in reserve, and a Tangye pump of 3,000 gal. per hour is used for pumping clean water for the use of the natives. The lighting plant consists of an Ellwell-Parker dynamo with 50 lamps of 16 candle power, and a small Tangye engine. The new shaft is placed close to the line of railway, with which the loading floors are connected. The shaft is 13 ft. by 9 ft. with two hoisting ways and a pump way, each 4 ft. by 9 ft. Cages carry two 20 cubic feet trucks, equal to about 18 cwt. of merchantable coal. The shaft is 131 ft. deep (156 ft. to the delivery platform).

The present output from the shaft is 1,000 tons a shift of 10 hours, but this can be increased to 1,500 tons without any extra pressure upon the facilities. The hoisting is done by a coupled 15x20 Daglish engine, with 8 ft. 6 in. drums. The delivery platform on the headgear is very large, being 75 ft. x 50 ft. To obtain the necessary fall to the screen it has been built 25 ft. above the ground and its timbers covered with a flooring of sheet iron.

The steam for the surface engines and that under ground is drawn from three Babcock and Wilcox boilers. The water used is very impure, owing to the sulphides in the coals. Magnesia and lime compounds are also present.

The coal bed is practically horizontal, 12 ft. to 14 ft. thick. The roads are 10 ft. wide and 7 ft. or 9 ft. high, and lighted by electricity. Endless cables are in use in some of the roads, and this system will soon be much extended. The principal road has a cable for 1,800 ft., with a cable of 900 ft. at right angles driven off it by means of double pulleys. In the side roads mules are employed. The mining is all done by natives under the superintendence of Europeans.

The usual pillar and stall system has been adopted, the pillars being about one-fourth of the total quantity developed. An excellent roof of shale is found almost throughout. Only three boys have been killed during the last two years. The coal is almost free from shale bands and it is the practice to mine everything and sort out the small proportion of shale at the belts. The deposit differs from European fields in the absence of cleavage lines. This has the effect of making the mining costs higher, for the coal appears as a solid and unbroken mass and no advantage can be taken of the usual natural divisions. The probable recent character of the deposit and the absence of any weight of superincumbent rocks and corresponding pressure, are doubtless, the reasons for this absence of cleavage.

Dynamite is used. The drilling is all done by native miners, but Mr. Williams declares in favor of coal cutters, preferring the percussive type driven by compressed air as being lighter and more easily handled. The cheap labor of the native miner has assisted to prevent their adoption, but it is the question of initial cost which is the principal objection urged against them.

The total quantity of the clean coal, round and nut, produced to date is 859,459 tons; the proportion of waste has not been less than 20 per cent., and 25 per cent. of the total quantity developed is still in the pillars. The monthly tonnage is increasing, and the output of this year will probably considerably exceed 300,000 tons.

Utilization of Water Power.

The new mills of the Grand Rapids Pulp & Paper Co., at Bearin, on the Wisconsin River, are being rapidly pushed forward. The company is constructing a dam, excavating a large mill pit from solid rock, and erecting large substantial brick buildings. They have contracted with James Leffel & Co., of Springfield, Ohio, for 15 of their large Samson Turbine Water Wheels, which will be in position in November. All the work is being done upon the most approved plan, and is of the most substantial character.

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ILLINOIS COAL MINES.

THE Thirteenth Annual Report of Mining, issued by the State Bureau of Illinois is at hand, and like its fore-runners, it is full of that class of facts that are required in the construction of history, in the gauging of the resources of the commonwealth, in stimulating the progress and development of trade, in finding the advantages or otherwise of new mechanical appliances and modes of working, and above all in finding what we should, and what we should not do to reduce the loss of human life, and more, and more curtail the causes of accidents in mines.

Historically this report records the great depression in the coal trade in Illinois, and throughout the United States and the world in 1894, and the occurrence of the common accompaniment of bad sales, and low prices, namely, a strike with all its attendant misery, vexations, and blighted hopes.

The mines were closed for 61, and the miners were idle for 73 days. So great are the national resources, that notwithstanding the slackness of trade and a strike combined, the output of coal in the State of Illinois for the year of 1894 was 17,113,576 tons against 19,949,564 for 1893; and thus it appears that had no strike occurred the output in 1894, would at any rate have been equal to that of 1893.

The number of miners in the State of Illinois is 32,046, but that number is increased by 6,431 the number of persons employed above ground, thus making the grand total of employes 38,477.

There is an increase in the percentage of fatal and non-fatal accidents in the mines of the State, and we hope this will be reversed in the Bureau report of 1895. While expressing this wish we are not unmindful of the fact that every strike is a fruitful source of accidents, for during the cessation of work, the roof settles and becomes traversed with unseen cracks and joints, while the floor is broken and tends to rise, and thus the pillars are shattered and made unstable, and the result is, in this and other ways, unseen and unexpected causes of danger arise.

Perhaps no greater cause of danger ever arises than that of the new environment of the miners themselves, for they are "stiff" and awkward after a strike, and as their employment is then often at unknown mines, they are reckless and venturesome, and it is only after painful experience that they begin to practise prudence.

Machine mining has become an important item in the Bureau reports, and deserves close and careful attention. The writer has long believed as a practical man that there were conditions of the roof and floor in some coal-seams that made the use of coal cutters impossible, and he has frequently expressed as his opinion that machines may be made to cut under a longwall face where the roof would stand without timber. This has been accomplished and we must not forget that machines may yet be made to work in a "forest" of timber, or if our own conversatism is subdued, the timbering may be done to suit the machine. At any rate we have now to confront an established fact, not only that machines can cut coal, but that they can so cut the coal as so to obtain a larger percentage of "lump;" and further, in the Bureau report of Illinois for 1894 we have among other tabulated statements, tables of "Mines in which Machines are used exclusively," and of "Mines in which Machines are used, but not exclusively." We cannot do otherwise than commend the steady progress of machine mining.

Twenty-five years ago, much was expected and little of a practical character was accomplished by the machines in England, but with improved modes of transmitting energy, and increased experience of the requirements of the machines, the results commercially are better and better, and we cannot even yet speak of finality in machine development, especially in this country.

Although ten additional fans have been introduced in 1894 for improved ventilation in the mines of Illinois, yet still more than double of the present number are required before the primitive modes of ventilation are entirely displaced. Still although there are 296 mines ventilated with fans, 176 with furnaces, 21 with steam jets, and 301 with natural ventilation, if we consider the fan in relation to the number of men employed it is very far in the ascendant. Fan ventilation is provided for 33,470 men; while furnace, steam jet, and natural ventilation is provided for 4,859 men, or nearly 7 out of every 8 miners in the State are provided with fan ventilation.

When we consider that many of the so-called mines are only small workings for an exclusively local supply, we need not wonder that 301 "mines" have natural ventilation. But as the coal trade of the State increases and extends, in the future the small mines will become large ones furnished with all progressive improvements, and the furnace and natural ventilation will disappear.

AUSTRIAN EFFORTS TO PREVENT ACCIDENTS IN MINES.

THE Prevention of accidents in mines is the constant care of the Austrian government, and nothing that legislation can do has been left undone to enforce a practice that is good or prevent one that is bad.

With the use of flameless explosives, miners are beset with two dangers that these very "safety" compounds introduce, namely, strong *flaming* detonators and shots that *deflagrate* instead of explode. The dangers due to the use of strong detonators are evident enough, but when a shot deflagrates or vomits a stream of hissing fiery sparks like a rocket, the most certain mode of igniting coal-dust or fire-damp is present.

Nitrate of ammonia, or other like nitrates are used to chill the flame of combustion in explosives of the flameless class, because the nitrogen of these compounds absorbs the heat in a latent form, but the consequent reduction of temperature or tendency thereto renders the charge difficult to ignite, hence powerful detonators *must* be used, and when an excess of the nitrate dilutes the heat of combustion too much, instantaneous firing is prevented, and the shot burns slowly or deflagrates.

This is not true of all the flameless explosives, but it is true of many. In Austria all fuses of the fire kind have been found to be dangerous, and therefore, firing by electricity is preferred, but above and over all, they find that the dangers due to shot firing are, regardless of the class of fuses, detonators, or explosives used, most surely reduced and almost removed, by employing intelligent men that have received a befitting education for the work of examining for gas, and firing the shots. Experience has fully demonstrated that neither life nor property is safe when in the keeping of densely ignorant men.

In Austria, to secure the safety lamps against the interference of the miners who use them, a magnetic lock was introduced, but ignorance and stupidity if not constructive are always destructive and here is the proof. "From October 20, 1894, when a serious colliery accident occurred at Anina, to November 20, in the same district, no less than three cases of opening Wolf's benzene lamps were detected, and in two the magnetic locks were uninjured, for the miners found that by swinging their lamps violently against the ground with both their hands, they could make the inert force of the lock bolt overcome its magnetic force, and thus open the lamp, and further the miners actually have been found to force out of the fountain of the lamp a small portion of flaming benzene to light their cigarettes in the mines. What then in the face of all this must be done? Surely state enactments, scientific experiments, and mechanical and constructive improvements are no security against the force of ignorance.

To make mines safe and profitable, we must encourage the younger men in them to obtain such instruction as will brighten and elevate them, and fit them to be our protectors.

Francis Joseph, the Emperor of Austria, has done much to obtain a flameless explosive, but he cannot cure ignorance that is a greater danger than flaming explosives.

ADVANTAGES OF A LIBERAL MINING EDUCATION.

THE great desideratum at present in the mining world is a combination of surveyor and scientific expert in the most comprehensive sense of the term. To be able to survey and level, and plot maps and sections should only be a small portion of what he can do, for in addition he must be a geologist, a chemist, a mineralogist, a metallurgist, an assayer, and a good prospector.

Any man furnished by industry and education with the fitness here outlined cannot fail to make a success either as an agent for a company, or operating for himself individually.

A mine owner from the mining regions of South Africa, told the writer that it was only through the practice of great diplomatic skill that anybody could make any money, because it required such a staff of opposing elements among the employes to determine the values that justified speculation and enterprise. Surely then when men discover they have character and brains, and aim at making life a success, they ought to qualify for a profession that is full of adventure and cash, and especially is this the case when we have a whole profession with but a few practitioners. Such an expert would take high rank in the confidence of a company and secure that kind of stability that is necessary for success. He would be well informed in the theory and practice of ore dressing, and along with a first-class mine captain would make a mine successful where the mine captain alone would fail, because the expert would not only be able to correctly gauge the yield of the matrix, but he would know what particular class of dressing machinery would be best adapted for the ore to be treated.

The practical miner is very good within the boundary lines of his experience, but a lead miner from a limestone region would fail as a tin miner in the granite, and so it is, many good miners have condemned good ground, because they could not associate it with the ground of their experience, thus proving the small compass of their mining resources.

Geological, mineralogical, and chemical tests cannot deceive us, therefore, they must take the fore-front. The reader will now suppose that the mine superintendent must take a back seat, but that can never permanently happen, for who is so likely to acquire and practice the necessary education as he, especially if he aspires to do so?

It does not pay to stand back and see others advance. The watchword should be forward. Mr. Nicol Brown, F. G. S., England said before a meeting of the Geologists Association, that "Mining operations should be under the control of an educated and experienced mining superintendent. He must be a practical miner, and should have had experience in mining various ores in different parts of the world. It is a great disadvantage to employ a miner whose prejudices have been developed by long experience in one particular series of rocks or of the physical structure of one country.

"Such a man, however capable otherwise, has no resources when he comes to deal with new geological conditions. A vast industry of the first importance is needed to gather out the infinitely small scattered portions of gold as they exist in nature. The directors of the Bank of England may hold the key of the Bank's gold, but the geologist holds the golden key of knowledge to the earth's store house of the kingly metal."

WE congratulate our contemporary *Engineering News* in securing the services of Mr. Wm. Kent, as one of its associate editors. He will prove a valuable addition to the able staff of the journal. He will have especial charge of all matters relating to mechanical and metallurgical engineering. Mr. Kent has been a member of the American Society of Mechanical Engineers since its establishment, in 1880, and has held the offices of Manager and Vice-President. He has been for nineteen years a member of the American Institute of Mining Engineers, and is the present Chairman of the Section of Mechanical Science and Engineering in the American Association for the Advancement of Science. His valuable contributions to engineering literature, in the transactions of these societies and elsewhere, with his wide professional experience, have made him well known throughout the engineering profession.

LEGAL DECISIONS ON MINING QUESTIONS.

Reported for THE COLLIERY ENGINEER AND METAL MINER.

Effect of Vein Crossing Side Lines.—Where the course of a vein or lode is across the claim, instead of in the direction of its length, the sides of the location become the end lines, and the end lines the side lines. It is a question, whether, in a case in which a vein or lode passes through one end line and one side line of a mining location, the owner of the claim has any right to follow the dip beyond the vertical plane of his side lines within the limits of some equitably created new end lines, or is limited to the common-law rights of an owner of real estate, and nothing more; and whether, in case the location is amended so as to cut off one end of the claim, and thus make the vein pass through both end lines, assuming that such amended location is valid, the rights acquired under it are to be regarded as relating back to the date of the original location, so as to give a right to follow the dip underneath an intermediate location, or as arising simply at the time of amendment, in which case the intermediate location would have the prior right.

Last Chance Min. Co. v. Tyler Min. Co. 15 U. S. Sup. Ct. Rep. 733.

Insufficiency of Complaint.—A complaint in an action for injuries to an employe caused by failure of a mining company to make safe the roof of its mine, and which fails to allege the company's knowledge, or the employe's want of knowledge, of the condition of the roof, is bad on demurrer, though it alleges generally negligence on the company's part, and want of negligence on the employe's part. The sufficiency of the general allegations of negligence and want of negligence in ordinary cases, where negligence is sought to be put in issue, cannot be controverted. It is the duty of the master to exercise reasonable care to provide safe working places, appliances, and machinery for his servants. Where a recovery is sought for the master's neglect of his duty with reference to safe place or appliances, knowledge of the defect by the master, and want of knowledge by the servant, must be affirmatively shown by the complaint. The servant's knowledge or want of knowledge must be specially alleged, because upon this it depends whether or not he is to be held to have assumed the risk of the defect, assumption of the risk and contributory negligence being separate and independent factors. It is also established by the authorities that the allegation as to knowledge includes not only actual, but constructive knowledge.

New Kentucky Coal Co. v. Albain. (Appellate Court of Indiana.) 40 N. E. Rep. 702.

Sale of Portion of Mining Claim.—If the locator of a mining claim should convey a portion of his claim, without any reservation in his deed of conveyance, his grantee would be entitled to all the gold that might be found within the ground conveyed, in any vein whose apex was within the surface lines of his deed. So if a locator should convey to A. the east half of his claim, and afterwards should convey the west half to B., each of his grantees would, in the same manner, be entitled to all of the gold found in any vein which was entirely within the surface lines of his conveyance; and, on the same principle, if the proprietor of a tract of mining ground which has been derived through several locations should dispose of the same in parcels, irrespective of the lines of such locations, the rights of his grantees would be measured by the terms of their deeds. In such cases section 2,336 of the Revised Statutes of the United States has no application. That statute was not intended to limit or define the rights of a person in mere possession of a tract of mining ground, where there is more than one vein, or to prescribe the effect of a conveyance by the locator of a claim of a portion of his location containing one of such veins. The object of the statute was to supplement the provisions of section 2,332, and to prescribe rules under which different locations by different proprietors should be held, and to determine the rights of such proprietors in case of intersecting veins. The position of the proprietor of a mining claim, who conveys a portion, and retains the remainder, is analogous to the position of the United States after it has issued its patent for a location.

As the United States, as well as a subsequent locator, holds the unpatented claim subject to the prior rights of the patentee, as prescribed by section 2,336, so the grantor of a portion of his claim, in the absence of any reservation in his deed, or proof of mining customs, holds the ungranted portion subordinate to the rights of his grantee in the ground conveyed. When mining ground is conveyed by deed without express limitation, the grantee takes subject to the characteristics of mining property given to it by prevailing customs and laws, and not with the absolute dominion which flows from a conveyance in fee of ordinary land. The mining land thus granted is still subject to all mining laws and customs which are applicable, but the provision of section 2,336 that, when two veins intersect, "priority of title shall govern, and such prior location shall be entitled to all ore or mineral contained within the space of intersection," cannot possibly be applied to the case where A. conveys part of his mining claim to B., for in such a case there is no "prior location." Therefore in such a case the ordinary rules which govern grants of land must, of necessity, apply, and if the intersection takes place on part of the claim conveyed the grantee takes all the mineral within the space of intersection.

Stinchfield v. Gillis, (Supreme Court of California,) 40 Pac. Rep. 98.

Right To Follow Dip In Overlapping Locations.—A controversy arising from overlapping locations, after being carried on both before the land office and the courts, was compromised by allowing one of the locations to patent most of the disputed land. A company was then organized, representing both parties to the dispute, and the land was conveyed to it. It was held, that this company could not refer its title to either or both of the contending locations, at its election, so as to give the right to follow the dip within the end lines of either location at will, but, on the contrary, it must derive its rights in this respect solely from the location under which the patent was obtained. The fact that the apex of a vein, on its strike, passes through one end line and one side line of the location, does not cause both of these lines to be regarded as end lines, so as to destroy the parallelism, without which there is no right to follow the dip laterally beyond the boundaries of the claim. On the contrary, the owner of such a claim will have a right to follow the dip, within his original end lines, so far as he holds the outcrop within his location.

Del Monte Mining & Milling Co. v. New York & L. C. Min. Co. (Circuit Court, D. Colorado.) 66 Fed. Rep. 212.

Construction of Contract.—A provision, in a bond for title to an undivided interest in a mining claim, that the vendees are to pay the vendor one-sixth of the net proceeds of all shipments of ore, to be applied on the agreed price, is unambiguous; and parol evidence is inadmissible to prove that, according to a custom of miners, the expenses of mining as well as of shipping the ore should be deducted before such payments.

Keefe v. Doreland, (Supreme Court of Montana.) 39 Pac. Rep. 916.

Liability for Injuries to Miner.—In an action by a miner against the owner of a coal mine for damages for an injury sustained by the falling of an overhanging part of the roof of the mine. It was contended that the injury was occasioned by the failure of the mine boss, a fellow servant, to do his duty in keeping the roof of the mine safe. "If it were conceded that the mine boss was the fellow servant of the miner, and not the representative of the employer, still his negligence would not absolve the employer, although it may have concurred with the negligence of the latter in producing the injury. Where the master is negligent, he is responsible, although the negligence of a fellow servant may have concurred in bringing injury upon the employe. An employer must answer for his own breach of duty to his employes, even though one of his employes was also guilty of negligence which contributed to the wrong done to the injured employes. This rule rests on solid principle. It is no more than bare justice to compel a wrongdoer to answer for the proximate consequences of his own negligence, and it must be to the last degree unjust to permit him to escape responsibility upon the ground that some one else was also guilty of culpable negligence. The duty of the master to exercise ordinary care and skill concerning the place in which the servant is required to work is a continuing duty, and the master cannot escape responsibility for failure to keep such place safe by delegating the performance of the duty to another; and the servant may rely upon the master to perform this duty. It is well established that where negligence of the master combined with the negligence of his servant produces injury to a fellow servant, the injured servant may recover damages of the master. That the mine boss was acting for the master when he gave directions to the miner to enter the room, and that the miner was justified in obeying the directions, is not seriously questioned, but shows such negligence as will hold the mine owner liable, whether the mining boss was a fellow servant or a vice principal, when he negligently failed to maintain the roof of the mine in a safe condition for the employes to work in.

Island Coal Co. v. Rischer, (Appellate Court of Indiana,) 40 N. E. Rep. 158.

BOOK REVIEW.

A HANDBOOK FOR SURVEYORS, by Mansfield Merriman, Professor of Civil Engineering in Lehigh University and John P. Brooks, Instructor in Civil Engineering in the same institution. 16 mo. 242 pages. Bound in morocco with flap. Price $2.00 published by John Wiley and Sons, New York. As usual with publications written and compiled by Prof. Merriman, this is an exceedingly practical book. It is designed for the use of classes in technical schools and also as a field book for surveyors. It covers the subject in 4 chapters and 14 sets of convenient tables. Chapter I, is devoted to Fundamental Principles, Chapter II, to Land Surveying, Chapter III, to Levelling and Triangulation, and Chapter IV, to Topographical Surveying. The tables are in convenient form and cover every class used in field and office work.

REPORTS RECEIVED.—Coal Report of Bureau of Labor Statistics of Illinois for 1894. Fourth Report of the Bureau of Mines of Ontario. Report on the Use of Metal Railroad Ties, and on Preservative Processes and Metal Tie Plates for Wooden Ties, by E. E. Russell Tratman, A. M., prepared under the direction of B. E. Fernow, Chief of Div. of Forestry, U. S. Dept. of Agriculture. Report of the Canal Commission of Phila. to Select and Common Councils, on the most feasible route for a ship canal between the Delaware River and Atlantic Ocean.

Catalogues Received.

We have received from the C. W. Hunt Co., of 45 Broadway, New York, an exceedingly handsome catalogue of machinery for coal handling for steam generation. Like all the other catalogues of the C. W. Hunt Co., it is well illustrated and interesting.

The Phila. Engineering Co. send us three catalogues designated as "L", "M" and "N." Catalogue "L" describes fly wheels in a thoroughly technical manner and shows that the company's engineers devote as much care to designing and proportioning fly wheels as they do to other pieces of machinery.

Catalogue "M" contains rules and tables for the equalization of power developed in the cylinders of compound engines.

Catalogue "N" is devoted to condensing and non-condensing engines for rolling mill work.

Compressed Air and The Clayton Air Compressors is the title of an excellent publication of 86 pages devoted to the various uses of compressed air, and to descriptions of the Clayton air compressors, etc.

Work Placer Mines Carefully.

The object which has hitherto guided the operations of the placer miner has almost always been to take the cream, if one may use such an expression, and to leave the skimmed milk; to hurry through the ground, taking out the bulk of the gold with the greatest possible economy of time and labor, and to let the rest go. This is one great reason why the patient Chinese can make a living out of ground that has been abandoned by white miners. The evils of such a practice are self-evident. Very much of what is left is so disseminated, and the ground is rendered so unworkable, that it is doubtful whether it can ever be recovered. Placer miners are now, however, beginning to realize the importance of taking a little more care to save as much as possible of the precious metal, and the various improvements in machinery, etc., which have been brought into more general use, for saving the fine gold, is attracting more attention to placer mining each succeeding season.—*Ex.*

PERSONALS

Mr. F. P. Gridley formerly with the Union Pacific Coal Co., at Scofield, Utah, has resigned and accepted the superintendency of the Diamond Coal and Coke Co., at Diamondville, Uintah Co., Wyoming.

The Lidgerwood Manufacturing Company of New York City have in the press a pamphlet entitled "Travelling Cableways and Some Other Devices Employed by the Contractors on the Chicago Drainage Canal." This book will be one of their well known sketch book series, same size as the previous issue, and will contain 72 pages, 36 full page illustrations and is intended particularly to illustrate the multiplicity of uses to which the Lidgerwood hoisting engines can be placed. The Travelling Cableways, twenty of which have been sold and used on the Chicago Drainage Canal, occupy the larger part of the book. It will be free upon application and those desiring a copy should apply at the New York headquarters of the Lidgerwood company, 96 Liberty street.

The Abendroth & Root Manufacturing Company, has of late filed a number of notable orders for their improved Root water tube boilers, principally in New York City and vicinity.

It may be mentioned in this connection that Arthur Loretz, Jr., formerly New York manager for the National Water Tube Boiler Co., is now representing the "Root" boiler at 28 Cliff street, New York City.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

Mesozoic Reptiles.—The following is taken from the *Black Diamond*. One of the most remarkable finds made in our time was the discovery in 1878, of a herd of twenty-five gigantic land reptiles, called "iguanodon" which had been accidentally drowned in an ancient river gorge, cut by a stream through several hundred feet of coal measure strata, forming in jurassic times, one of the lesser valleys of Belgium, which was at that remote time a land surface, as it is to-day, but covered then with cycads and tree-ferns and other semi-tropical plants of the Wealden period.

The river was well stocked with fish having bony enamelled scales, like the American bony-pike, whilst the banks of the river formed the home of lizards, crocodiles, water tortoises and hugh iguanodons.

Thick vegetation of ferns and other plants clothed the marshy margins of the stream, and in times of floods, which were not infrequent, the giant iguanodons with the plants they fed on, together with many reptiles and fishes of the stream, were all entombed in a common grave and covered up with deposits of fine mud left by the river. In process of time the valley was quite filled up with sediment, and in modern days, when coal pits had been sunk at Bernissart, between Mons and Tournay, near the French frontier, the old Wealden or jurassic valley, was re-discovered at more than 1000 feet beneath the present surface of the ground.

At one spot instead of workable coal, the mine galleries traversed for 400 feet only barren ground, composed of chalk and green sand; here in the black Wealden shale the miners met with the remarkable series of skeletons of the iguanodons which were with great difficulty extracted in many pieces and brought to bank by M. Depauw and the engineers of the mine. They have since, with infinite labor, been put together by M. Depauw, and five of them have been set up in the Royal Museum of Natural History in Brussels. Through the kindness of M. E. Dupont, the director of the Brussels Museum, a cast of the entire skeleton has been acquired for the British Museum, and it has been set up in the reptile gallery of the geological department, where it forms one of the most striking objects ever presented to the gaze of the British public. The beast stands 15 feet high, and measures 30 feet along the vertebral column and covers about 156 square feet of gallery.

The Remuneration of Mine Surveyors in Germany.—From the *Colliery Guardian*. Throughout Germany mine surveys are conducted by a corps of highly-trained surveyors appointed by the Government and the amount of remuneration to which they are entitled is clearly specified by the Prussian Board of Trade. It has however, been found that the scale of fees fixed in June, 1876, is in many respects inapplicable at the present time, and a new scale has been drawn up by the Baron von Berlepsch, the Prussian Minister of Trade. This enactment comes into force this year, and the provisions it contains cannot fail to be of interest to mine surveyors in this country.

The remuneration, it is stated, may consist either of a fixed daily fee or of variable fees based upon the amount of work performed. The daily fee is $3.60 and this sum is payable for days spent in work or for days devoted to travelling on survey business, as well as for the Sundays and legal holidays which are necessarily spent away from home. A working day consist of eight hours, and a travelling day comprises a journey of at least four hours. For surveys that do not occupy a full day, the remuneration is computed at 48 cents per hour. If the mine surveyor is obliged to carry out his measurements between 8 P. M. and 4 A. M.; or on Sundays or legal holidays, he is always entitled to make a supplementary charge of 24 cents per hour.

As travelling expenses, mine surveyors receive for railway or steamboat journeys 5 cents per mile, inclusive of porterage of instruments and plans, and for the journey to and from the railway station 72 cents each way. For journeys not by rail or steamer, the rate is 7 cents per mile. If the residence of the surveyor is less than a mile and a half from the mine to be surveyed, no expenses are allowed beyond the cost of porterage of the instruments. Distances of 2 to 5 kiloms. (1.2 to 3 miles) are reckoned as 5 kiloms (3 miles). If on one trip the surveyor makes surveys for several mines, his travelling expenses must be borne by the various mines in proportion to the time spent at each. In lieu of the charge per mile, the surveyor is always at liberty to charge the sum actually disbursed on production of vouchers.

The fees based on the work done are somewhat complicated. The following are some of the principal details:—For surveys with the dial, vertical angles being observed, the charge allowed per 10 yards is 12 cents underground and 8 cents at the surface. When vertical angles are not taken, the charge is 10 cents underground and 5 cents at the surface. When back and fore sights are taken with a view to eliminate local deviation of the magnetic needle, the charge is 22 cents underground and 11 cents at the surface. For tacheometer surveys the charge is 14 cents for each point determined; for plumbing shafts, 24 cents for every 10 yards; for levelling, for each setting of the staff, 10 cents underground and 5 cents at the surface; for traversing with the theodolite, including measuring the angles, permanently marking the station, recording the observation, and plotting the point on the plan, for each station 72 cents underground and 48 cents at the surface; and for triangulation 48 cents for each angle of the triangle.

In fiery mines where it is necessary to work with safety lamps, a small supplementary charge is allowed. This is also the case in very wet or very hot (above 77 degs. Fahr.) mines or in workings less than 4 ft. in height.

The copying of plans of all kinds is to be charged for at a rate per 100 square yards of the area plotted, inclusive of lettering, which varies, according to the scale adopted from 4 cents (scale $\frac{1}{250}$ to $\frac{1}{500}$) up to 48 cents (scale $\frac{1}{2500}$ to $\frac{1}{10000}$). For copies in which the scale is greater or less than the original, this rate is increased one and a half to two and a half times, according to the amount of change of scale. Copying on tracing paper or on tracing cloth is reckoned at half the rate for copying on drawing paper. When the plans have to be colored the rate is increased a third. In all cases in place of these fees, the daily or hourly charge for the time actually occupied may be made.

The drawing paper, tracing paper, or tracing cloth, of the best quality, is charged for at a given rate, and the cost of field-books, etc., is reimbursed on the production of vouchers.

If the mine surveyor engages the workmen required to assist in the survey, he may enter in his account the wages he has to pay them. The wages must, however, be at most 25 per cent. above the mean wage of a coalgetter in the district in question.

A Competitive Trial of Flue-Heated Coke Ovens.—The report of this trial has been extensively published in the foreign mining journals and from which we extracted for "Progress in Mining" in our August issue, the particulars then given. In this synopsis occurs the statment that "The trials were conducted under the in-pection of controllers appointed by the competing companies" and as this statement is called in question by the Otto Coke and Chemical Company of Pittsburgh, Pa., the American representatives of Dr. Otto, we hasten to give their denial full publicity.

Pittsburgh, Pa., August 7th, 1895.

Editor of the COLLIERY ENGINEER AND METAL MINER,
Scranton, Pa.,

DEAR SIR:—In your August issue you publish a resume of a "Competive Trial of Flue heated Coke Ovens." The original report of this alleged trial appeared in full in "Stahl und Eisen" Dec. 15th, 1894, accompanied by the following very pertinent foot note by the Editor.

"We entertained some doubts in regard to publishing the above paper without having informed the firm of Dr. Otto & Co., at Dahlhausen a. d. Ruhr, as to the contents of same:—Our desire however, which was repeatedly made known to Mr. Huessener, has been declined by him. We believe that in such cases a referee or arbitrator would have been indispensable. Nevertheless, the publication has been decided upon, because the comparative trials and their results are undoubtedly of great interest to the majority of our readers, and the discussions that will most probably follow from coal distillers, may lead to valuable communications relating to this important branch of industry.

"In this case, another of our reasons against publication may be waived, *i. e.*, the rules laid down for the competitive coking test were agreed to by the representative of the Huessener system alone, while on the other hand, the Otto-Hoffman system had no representative, the owners of the ovens alone being a participant to the tests.

"The responsibility for the contents of the above article will remain with the author, Mr. A. Huessener."

THE EDITOR.

From this you will note that an important misstatement has been made in your article viz "The trials were conducted under the inspection of controllers appointed by the competing companies."

"Stahl und Eisen" Jan. 1st, 1895, publishes a criticism of the so called test, over the signature of Dr. C. Otto & Co. (for your convenience we append a translation in full of this answer). As an index as to the impression this so called test makes upon one of the leading German iron masters, we refer to an article in "Stahl und Eisen" Jan. 15th, 1895, (page 79) by Herr Pizak.

Resp'y. yours
OTTO COKE & CHEMICAL CO.,
JNO. F. WILCOX, G. M.

Translation from "Stahl und Eisen," January 1st, 1895.

The competitive coking test Bulmke vers. Germania.

In No. 24 of this journal Mr. A. Huessener, Manager of the "Actiengesellschaft fuer Kohlendestillation" at Bulmke near Gelsenkirchen, published a report accompanied by extensive data on "The competitive coking test between the Otto Hoffmann and Huessener Oven Systems."

We feel obliged to make a few statements regarding this report, but we do not need to go into details. Our statements will pertain to the subject matter and its origin. It is necessary to comment only upon a few essential points of the report which covers more than 20 pages of your journal, in order to characterize it.

According to Mr. Huessener's statements the following percentages of water were contained in the coke samples produced from the same coal at Germania Colliery and the "Kohlendestillation" at Bulmke:

PER CENT. WATER IN COKE.

Date.	Bulmke.		Germania.	
1893, August 7th	.706	.296	6.948	7.868
" " 8th	.336	.374	6.485	5.396
" " 9th	.875	1.475	5.396	2.485
" " 10th	.435	.205	8.526	4.666
" " 11th	.356	.285	4.315	7.445
" " 12th	.356	1.005	6.526	12.085
" " 13th	.996	1.235	4.065	5.375
" " 14th	1.134	.654	6.126	6.066
" " 15th	1.165	.805	7.595	7.055
Average	.63		6.55	

The comparison of these figures shows evidently that the coke at Germania has been most recklessly and cruelly abused, (the water having been determined in the large coke exclusively).

This "deplorable coke," which was forced to absorb up to 12% *of water* showed "a somewhat darker, not quite as silvery gray color and its appearance was not so uniform," as the Bulmke coke which had been properly quenched, even while very hot, and which did not contain on the average more than .63% water. It was not necessary to go to the Siegerland* to ascertain this.

Furthermore, it is thus easily understood that of this blackened coke a larger percentage was thrown on the pile of "half burned or waste coke" especially as the classification on *either* side was performed by employes of Mr. Huessener. We therefore could hardly expect anything else than a decreased coke yield at Germania, of 3½% (71.610% against 75.145%, according to the statements.)

It seems that equal amounts of quenching water of equal quality would be a very necessary proviso in a competitive coking test.

In the report it is furthermore stated that the *total* yield of coke, free of water, from Germania coal has been:

At Germania	80.656
At Bulmke	80.108

We are familiar with the said coking coal for many years, up to the present day, and know that it yields 76-77% coke in the crucible. Until to-day we have been unable to obtain in our Otto-Hoffman ovens, a yield in excess of this figure, and have never claimed it. We must therefore refuse, with thanks, to accept the increased yield of eventually 4%, attributed to us by Mr. Huessener. Whether the ovens at Bulmke actually performed such miracle, we cannot decide. The annual business report of the "Actiengesellschaft fuer Kohlendestillation," for 1893-4 does not confirm it, as it showed a yield from this coal of 69.63% coke and only .973% sulphate of ammonia.

We are unable to determine where to look for this discrepancy. It seems also that it would have been proper in a competitive coking test, to ascertain right along how much coke *could have been produced* from the charged coal. †

In a competitive coking test it must be considered as most important and indispensable that the rules laid down are to be strictly adhered to; for instance, if it is provided that the percentage of ash shall be determined day and night. Mr. Huessener's rules, which are published on pages 1110-1112 mention this, especially in article No. 5. This rule, however, has not been observed.

So much for to-day, to characterize the extensive publication. Regarding the origin of the test, the following may be stated:

At the close of the year 1892, our engineer, Mr. Meyn, was informed by Director Randebrock that the "Actiengesellschaft fuer Kohlendestillation" desired a competitive coking test, to which, of course, nothing could be objected. According to later advice, (Dec. 13th, 1892) the competitive coking was to commence about the middle of January and was to last for about 12 days. Inevitable repairs and a strike, however, made a postponement necessary. It was not before August 3d, 1893, that we were informed that the intended competitive coking test was to commence on Monday, August 7th, and it was not before August 10th that we received the rules, which were laid down by Mr. Huessener alone, and *which, up to that date, we had not even seen.* For this reason, and especially on account of already evident partialities in the carrying out, which were also characteristic of Mr. Huessener's report and which we could still further corroborate in a very efficient way, we could not accept the "rules." We actually did not accept them and entered our protest against such procedure.

(Signed) DR. C. OTTO & CO.

Dahlhausen on the Ruhr, Dec., 1894.

Non-Sparking or Polyphase or Alternating Electric Currents, for Mine Haulage and Pumping—This installation of electric hauling plant sets at rest the doubt concerning the safety of electric motors in fiery mines.

1.—*Installation on the Alternating Current System in the Erzherzog Albrecht Pit at Peterswald.*—As it was necessary to commence the extraction of the coal at this mine from a lower level than had before been customary, a new engine was required, and later on it was decided that the wagons should be drawn up and down the shaft by means of a traction cable. The transmission of power by electricity is well adapted to this sort of work; but as this particular colliery is subject to explosions from fire-damp, it was necessary to prevent the engines and electrical apparatus from sparking, which led to the adoption of an alternating current three-phase installation allowing motors without brushes to be employed.

The installation for the production of the electric current was situated on the ground level in the fan engine shed, and comprised a twin steam and condensing engine of old type belonging to the mine. It had been furnished with regulating valves in order that it should work as smoothly as possible. The power of this engine is 80 horse power at eighty revolutions per minute, and its flywheel drives, by the help of a transmitter fixed in the top of the shed, both an alternating and a continuous current dynamo. The alternating current dynamo is of the Siemens and Halske type R$\frac{4}{44}$; it furnishes an output of 44,000 watts, when the *outer resistance does not give place to induction*, but where the machine is driven by the motor, self-induction is inevitable and the power is reduced to 33,000 watts. In order to obtain this force a power equal to 50 horse power has to be expended, including that of excitation. The dynamo is so constructed that the continuous exciting current is conducted by two brushes and two collecting rings into the part excited by a rotatory movement, while the alternating current is received within the three boundaries of the fixed inductor. The alternating current dynamo is constructed so as to give a difference in potential of 500 volts, and therefore requires, at 750 revolutions, 1,200 watts furnished by the continuous current for the excitation of the field magnets. By increasing the power of the continuous current, the voltage of the dynamo may be easily carried to 600, and its power be proportionately increased.

The dynamo exciting with continuous current is of the H 6a type. Performing 1,050 revolutions, it produces an intensity of 50 amperes at 110 volts; it serves for the excitation of the alternating current dynamo and also for the lighting of the pit. This installation for the production of the electric current comprises, of course, all the necessary apparatus and instruments for the measuring, controlling and regulating of the two dynamos; the apparatus and instruments in question are placed on a

* Where the coke was tested in the blast furnace.

† Crucible tests of coal should have been made during the test.

table behind the platform where the engineer stands. Three cables are *detached* from the commutator for the transmission of power, each of them having a sectional area of copper of 35 mm. (1 mm. = $\frac{1}{25}$ in.). In the engine house and the mine the cables are covered with india rubber and *covered* by porcelain insulators, then they are continued by insulated copper conductors, wrapped in silk, on *oiled* insulators, and after running along a distance of 205 m. (224·19207 yards), reach that part of the pit where the wagons commence their movement and are continued for 20 m. (21·9872 yards) above the loading place. The conductors are entirely cased in wooden boards. Twenty-two yards above the loading place is a box connected with the cable as well as a *commutator*. From this box the conductor is formed of a cable encased in lead, and with triphase current, having iron bands and presenting a sectional area of copper 3 × 25 square millimeters in size. This cable is so placed as to be proof against all danger of deterioration and is continued as far as the receiver, placed 240 m. (262·4 yards) from the loading place, where it again comes into *contact* with a junction box, and is prolonged as far as the motor by a cable covered with india rubber.

The three-phase current motor is of direct derivation—that is to say, that the part excited by a rotatory *movement* has no brush nor friction ring, and consequently does not directly receive the current, which is conducted into the fixed induction coil. This motor developes a force of 25 horse power, at 736 revolutions and 475 volts.

Onyx Marbles.—A paper on the above subject will be read before the Atlanta meeting in October, 1895, of "The Institute of Mining Engineers," by Prof. Courtenay De Kalb, School of Mines of the University of Missouri, Rolla, Mo.

From the paper we learn that the word onyx is only applied in this case to distinguish a variety of beautiful and ornamental calcite, and is neither an onyx or a marble, for, says the writer, "In the beginning a sharp distinction must be drawn between the precious onyx, which is a cryptocrystalline variety of quartz, and the ordinary commercial "onyx" which is a deposit of carbonate of lime from aqueous solution."

It appears there are many varieties of the onyx marbles and the origin of the mineral may be detected by noticing the fact that some varieties are called the cave onyxes, and consist of cemented masses of stalactites and stalagmites, consequently it is interesting to know that the onyx marbles have their birth in the vicinity of limestone rocks. Further, true calcite, or dog-tooth spar, or crystalline masses of the true carbonate of lime do not constitute onyx marble, for says Prof. De Kalb:

"The requisite qualities for a commercial onyx marble are: First, perfect, or nearly perfect, homogeneity of texture; second, absence of subcrystalline structure, so that no tendency to crystallization may be observable by the eye; third, freedom from porosity and cracks." The natural conditions favorable to the formation of that variety of travertine called onyx marble, are engrossingly interesting to the student of mining, because through them we see how to explain much we meet with in the "filling" of veins and lodes. The conditions are: First, carbonic acid in solution; second, hot springs containing bicarbonate of lime in solution; third, limestone rocks in juxtaposition; fourth, the contiguity of volcanic hot springs."

Prof. De Kalb says: "From the foregoing summary it appears that the deposits furnishing the superior onyx marble of commerce are found in regions which have been subjected to volcanic disturbance; that they are superficial deposits or vein like inclosures, not connected in any manner with caves; that they are so frequently associated with active hot springs, or with other deposits manifestly resulting from hot springs, as to lead to a clear presumption that there must be a genetic relation between them and such hot springs; and finally, that they occur associated with limestone rocks, or with rocks yielding large percentages of lime." At present the most important deposits of onyx marble appear to be found in the Republic of Mexico, although some fine examples of the stone are found in many parts of the United States.

Improvements in Miner's Lamps.—A self-lighting miners' lamp has been invented by Herr Koch, manager of the Karolinengluck Colliery, near Bochum, in which no spare parts are required. The igniting strip is contained in an annular space, formed by pressing, without solder joint, in a metal ring underneath the cylindrical glass; and this space is sufficiently large to permit the strip to take from three to five turns according to the size of the lamp, thus accommodating a large number—up to 150—fulminate igniters. An advantage of this arrangement is that the heat radiated by the lamp flame keeps the strip and its chamber dry, and therefore the fulminate igniters in a good condition for performing their office. The igniting strip is made with a wire running through it, so that it can be drawn out of its chamber by being wound up on a small spindle, notwithstanding the combustion which takes place on ignition being effected as each fulminate igniter is drawn across a rubbing surface.

An igniting band which does not dim the glasses of miners' lamps and is not liable to miss-fire has been devised by Herr Heinrich Freise, of Hamme-Bochum, being prepared in the following manner, so as to burn without producing a sooty flame. A web, traversed at fixed intervals by a stronger thread, is coated with strips of igniting substance, sulphur and lycopodium mixed with a cementing medium, on one side while the other receives a coating of lycopodium, both sides of the web being afterwards varnished with collodion in order to ensure the continuance of combustion.

The arrangement of another saftey lamp has been patented by Herr C. Dalmann, of Herne, Westphalia, the special feature of which is that, by the side of the metal chimney and main gauze, a smaller and supplementary gauze cylinder is arranged, extending downwards from the level of the top of the chimney to near the flame, and the lower end being beveled off, for introducing the air necessary for combustion quite near the flame. The top and bottom ends of this supplementary gauze cylinder are closed by gauze caps, with the object of increasing the counter pressure when explosions occur in the inside of the lamp, and thus bringing about extinction of the flame. It is also recommended to protect the supplementary gauze by a fixed or removable shield, in order to still further increase the counter pressure on explosion occurring inside the lamp, and, if required, to regulate or shut off the air admission.

The Effects of Different Explosives on Fire-Damp and Coal Dust.—A paper on the above subject by Bergassessor Winkhouse, was read before The North of England Institute of Mining Engineers, and gave in detail the nature and results of some experiments in Westphalia, Germany, with different explosives fired in the presence of explosive gases and coal-dust.

Blasting powder was altogether excluded from the experiments, because the earlier investigations of the Prussian Firedamp Commission had shown that it was highly dangerous in all fiery and dusty mines and should therefore be no longer used in such mines. The substances which came into purview were:

I.—Among the non-safety explosives:

1. Gelatine-dynamit.
2. Kieselguhr-dynamit.
3. Stonite (Gesteins-carbonit.)

II.—As safety explosives:

1. Wetter-dynamit, from the Schlebusch dynamite factory, consisting of trinitro-glycerine, 52·9 per cent.; sulphate of magnesia (bitter salt, $MgSO_4 + 7 H_2 O$), 32·7 per cent.; kieselguhr, 14.4 per cent.

2. Carbonit (coal) which (according to the manager of the Schlebusch carbonite factory) consists of nitro-glycerine, 25.0 per cent.; nitrate of potassium, 34.0 per cent.; rye-meal, 38.5 per cent.; wood-meal, 1.0 per cent.; nitrate of barium, 1.0 per cent.; bicarbonate of sodium, 0.5 per cent. The chemical analysis of a sample showed that the proportion of nitro-glycerine was 29.5 per cent.

3. Sekurit from the Koln-Rottweil powder factories, consisting of ammonium dinitro-benzol, 29 per cent.; nitrate of ammonium, 37 per cent.; nitrate of potassium, 34 per cent.

4. Roburit from the roburit factory of Witten on the Ruhr, consisting of dinitro-benzol, 17.8 per cent.; nitrate of ammonium, 79.2 per cent.; ammonium chloride and ammonium sulphate, 0.3 per cent.; water (damp through long storage of the sample), 2.7 per cent.

In order to investigate as accurately as possible the properties of the various explosives, and in particular their behavior in presence of fire damp and coaldust, each alone or mixed together, every explosive was subjected to the following series of experiments:

1. Firing a shot from the upper cannon in the absence of firedamp and coaldust, so as to observe the breadth and length of the flame.

2. Firing of a series of shots with varying weights of explosive in order to determine the smallest amount which can, under the following conditions, ignite the explosive gaseous mixture, it being previously settled that such ignition can be brought about by the heaviest charges which it is possible to introduce into the cannon, say 16 to 20 oz. (500 to 600 grammes.)

(*a.*) In presence of coaldust strewed in the gallery and suspended in the air, without any firedamp being present.

(*b.*) In the midst of an explosive mixture containing 6 to 7 per cent. of firedamp, without any coaldust being present.

(*c.*) In the midst of a mixture containing firedamp, coaldust being at the same time strewed in the gallery and in suspension in the air.

(*aa.*) In presence of a gaseous mixture, such that the proportion of marsh gas present is just recognizable with a safety lamp, say about 2½ per cent. of firedamp.

(*bb.*) In presence of an explosive gaseous mixture containing 6 to 7 per cent. of firedamp.

With those explosives which, in presence of 2½ per cent. of firedamp, did not, even with heavy charges of as much as 17 oz. (500 grammes), ignite the coaldust, further experiments were made in presence of gaseous mixtures richer in firedamp (say 5 per cent. of marsh gas), yet not in themselves explosive, coaldust being strewed and in suspension as before.

Preliminary experiments were made to test the uniformity of the gaseous mixtures containing firedamp. The electric detonators were also subjected to test as to whether they would ignite firedamp, but no ignition ever took place.

As variable results were obtained according as the charge of explosive reached to the aperture of the borehole or lay at the bottom of the cannon, and also according to the length of free space left in front of the cartridge, a series of experiments was first carried out, in which the cartridges were so set within the cannon that they exactly coincided with the foremost edge of the borehole, and precisely identical conditions were arranged for each explosive. Another series of experiments was undertaken, wherein the explosive charges were simply placed on the bottom of the borehole, leaving in front of them a free space of about 5.91 in. (150 mm.) in length. No stemming was used in these experiments, as in the previous series. The study of the effects of stemming was reserved for a special set of experiments.

First Series of Experiments.—With regard to the first series of experiments (with the explosive in the foremost portion of the cannon) the following observations are given:—

1. That flame phenomena, more or less considerable, were observable in the case of every explosive. Those of greater intensity were noticed with stonite, kieselguhr-dynamit and gelatine-dynamit. The safety explosives gave rise only to short flames, and with coal carbonit only a feeble flash of light was observed.

2. From the point of view of their behavior in presence of coaldust without firedamp, gelatine-dynamit, securit, kieselguhr-dynamit, and stonite are to be regarded as by far the most dangerous. Charges of about 3·53 to 4·41 oz. (100 to 125 grammes) almost invariably sufficed to ignite a dusty atmosphere. Roburit and wetter-dynamit proved much more reliable. With these explosives the coaldust was ignited only by a charge of 10·58 to 12·34 oz. (300 to 350 grammes). The explosives westfalit and dahmenit, the cartridge cases of which had been strongly steeped in resin, paraffin, or ceresin, to protect them against damp, and were used, still in the original coverings, in ordinary working, ignited coaldust as soon as the charge reached about 9·88 oz. (250 grammes). But if the explosive, instead of being enclosed in a paraffined covering, was simply wrapped in an ordinary paper one, ignition of coaldust did not take place, even with charges as heavy as 17·59 oz. (495 grammes). With progressit the dangerous influence of the paraffined cartridge cases was not at first noticed. The biggest charges which could be set in the cannon in the original cases (that is, 15·87 oz., or 450 grammes) failed to ignite coal-dust. The same observation applies to coal-carbonit.

3. In the presence of gaseous mixtures containing small percentages of firedamp (say about 2½ per cent. of marsh gas) the safety of the greater number of explosives was found to diminish in a very remarkable degree. The accompanying table shows the smallest quantity of the several explosives which would produce ignition. Progressit and coal-carbonit proved in this case to be safe in charges of 14·11 to 15·87 oz. (400 to 450 grammes):—

Name of explosive.	Weight of explosive. Ounces.	Grammes.
Gelatine dynamit	2·64	75
Kieselguhr dynamit	2·64	75
Stonite	3·92	111
Securit	1·76	50
Roburit	5·37	152
Wetter-dynamit	7·06	200
Westfalit	10·58	300
Dahmenit	10·58	300

4. In explosive gaseous mixtures containing high percentages of firedamp (say 6¼ to 7 per cent. of marsh gas) the following minimum charges of the various explosives sufficed to bring about ignition. No essential difference in regard to ignition was noticed when coaldust was strewed at the same time, and such differences as were observable may be attributed to purely accidental circumstances:—

Name of explosive.	Weight of explosive. Oz.	Grms.	Pit gas without coaldust. Percentage of marsh gas.	Weight of explosive. Oz.	Grms.	Pit gas with coaldust. Percentage of marsh gas.
Gelatine-dynamit	1·76	50	6·20	1·59	45	6·50
Kieselguhr-dynamit	2·05	58	6·50	1·05	30	6·80
Stonite	2·86	81	7·00	—	—	—
Securit	5·29	150	6·40	—	—	—
Wetter-dynamit	2·40	68	6·30	1·80	51	6·60
Roburit	5·44	154	6·10	4·59	130	5·80
Westfalit *	8·97	254	7·10	8·82	250	6·30
Dahmenit *	8·97	254	7·30	8·82	250	6·20
Progressit *	19·42	550	6·75	19·77	560	7·25

Coal-carbonit, even in charges of 21·18 oz. (600 grammes), and in the presence of 7·3 per cent. of marsh gas, did not produce any explosion of firedamp.

Folds and Faults in Pennsylvania Anthracite Beds.—A paper on the above subject will be read in October, 1895, at the Atlanta meeting of "The American Institute of Mining Engineers," by B. Smith Lyman, of Philadelphia, Pa.

The paper is illustrated by 33 page-plates containing 177 sections copied from the State Geological Survey.

The writer has only one aim and that is to disprove the conclusions of Prof. H. D. Rogers concerning the prevailing abruptness of the incurvation of the northwest slopes of the anticlinal waves in Pennsylvania.

To make the object of the paper clear let us first quote the contention of Professor Rogers.

"There exists among undulations of the strata in Pennsylvania a few—they are very few—exceptions to the almost universal law of a superior degree of abruptness of incurvation upon the northwest slopes of the anticlinal waves.

"There are a few examples of unusual steepness of the southwest dips in the primary class of flexures; but nearly every one of these exceptions applies to only a local portion of the wave, and will be found connected either with a fault in the strata, or with an oblique interference of the end of an anticlinal of another group."

Mr. Lyman's views are expressed in the following paragraph: "We may conclude, then, that steep northerly dips in the Pennsylvania anthracite region are much less prevalent than was formerly supposed; that nearly half the basins and saddles are about symmetrical; and that nearly three-fourths of the subordinate ones are so in the Western Middle field, but that less than a quarter of the main ones are so in the Southern field." Mr. Lyman gives the following table of what he calls "Percentages of Equal and Steeper Dips" or what Professor Rogers would call equal and more abrupt incurvations.

Anthracite Fields	Main Folds. Equal.	North.	South.	Subordinate Folds. Equal.	North.	South.
Northern	38½	27¼	34½	40½	38½	21
Eastern Middle	33½	53	13½	37¾	51½	10¾
Western Middle	45	40½	14½	71	20½	8⅝
Southern Middle	21	60	19	60	37½	12⅝
All the Fields	37½	48	14½	48	38	14

The columns "Equal" mean the incurvation is equal on each side of the wave, and North or South means that the abrupt incurvation is greater on the North or South side of the anticlinal wave.

Strange to say both the Professor and Mr. Lyman are right from their own points of view, for it is clear that the rock waves were produced by lines of force acting at right angles to the axes of the anticlines, and as the axes of the waves run from the southwest to the northeast and the crumpling force acted from the southeast to the northwest, the inception of the force was greatest at the southeast, as is proved by the high percentage of abrupt incurvatures on the northwest sides of the anticlines, namely, 48 per cent. by Mr. Lyman's figures. We are obliged to admit that Professor Rogers is somewhat right, and not even ignorant of Mr. Lyman's own conclusions for he says, that the exceptions "will be found connected either with a fault in the strata or with an oblique interference at the end of an anticlinal of another group." Again Mr. Lyman is right, because all the abrupt incurvatures are not on the northwest sides of the anticlinals but the observations of both Mr. Lyman and the Professor are in harmony with the results of the direction and mode of action of the force that produced the great rock waves of Eastern Pennsylvania.

FIRE-RESISTING PAINT.

A Paint That Has Stood Severe Tests and Will Prove Effective in Protecting Mine Buildings From Fire.

Some remarkable results are reported from the use of the Jamieson fire-resisting paints and kalsomine. Recent severe tests have shown that a wooden building protected by only two coats of this product will effectually resist ignition. In a large fire at Carteret, N. J., last year the value of this paint as a check on the spread of flames was illustrated. The cut presented herewith gives a veiw taken three days after the fire.

The three buildings standing in the background were protected by Jamieson fire-resisting paints; the ruins represent several acres of buildings painted with ordinary paint. Every building painted with ordinary paint, we are informed, was totally destroyed, while none of the buildings painted with the Jamieson fire-resisting paint were sufficiently injured to require repairing.

The burned blocks of buildings were only about sixty feet removed from the buildings painted with the Jamieson fire-resisting paint, and extended lengthwise beyond them on either end. The direction of the wind during the fire was directly from the burning buildings toward the unburned block, and although the covering boards were badly scorched in several places, they did not ignite. Owing to the almost entire absence of fire appliances, it was considered certain that had these buildings once caught fire in any one spot they also would have been totally destroyed, and that they did not catch fire was undoubtedly due to their protective coating of Jamieson fire-resisting paint.

A practical test like this on a large scale is in some respects of more value than prepared tests on a small scale, no matter how carefully the details may be arranged. In one of such tests lately held some very satisfactory facts, however, were brought out. This test was made in the presence of the representatives of the New York fire department, building department, dock department, board of fire underwriters and of several large railroad and manufacturing companies. The following description of this test is given:

"The ordinary course of these events is that the conflagrations start in some light, quickly-burning and very inflammable substance; for example, paper, shavings, oil waste, etc. From these any adjacent heavier combustibles are ignited. The wooden portions of a building, as a rule, furnish the readiest fuel, and are the best means of spreading the fire. To imitate the regular course of events, therefore, a large cask of hardwood was placed in the building, filled with shavings and the whole soaked with kerosene oil. The match was then applied, and immediately the oil-soaked shavings burst into flames, completely filling the building. At the same time the outside of the building was surrounded with similar fuel (shavings and hard wood barrel staves), and the attack started from the outside as well as the inside.

"After several minutes, the shavings and oil having burned out and the barrel staves having caught, the flames became less in volume, but of greater intensity, and the spectators retired to a distance, and, shielding their faces from the intense heat, expected the destruction of the building. Matters were stimulated by throwing on a few gallons of oil at intervals. Then the fuel was allowed to burn itself out, and as soon as the flames from the barrels died down and the building was cool enough to approach, it was seen that the boards had not caught fire at all, and the only damage was a charring of the surface.

"The process of firing was then repeated and continued for a period of one hour and twenty minutes, the only intermissions being a few seconds at a time to see whether the building had taken fire. The intense heat gradually charred the wood away until holes were burned completely through the side and roof, but still the building did not take fire, the nearest approach to it being at the edges of the boards, where little flickering flames appeared, which, however, made no headway, but died out when the fuel ceased to burn. Finally the building was upset over a mass of burning barrel staves, but still refused to break into flames.

"The total time of test was one hour and twenty minutes, and the actual time of exposure to intense fire (deducting the time of stoppages for examination) was one hour and ten minutes.

"The results of the test satisfied those present that a building of ordinary pine lumber can be protected from fire by a simple and necessary operation without any increased cost of construction, viz, by painting with the Jamieson fire-resisting paint or kalsomine. It was further shown that light and inflammable pine, if coated with the Jamieson fire-resisting paint or kalsomine will not actively burn, but must be slowly charred away by the heat from some external fuel." The manufacturer of this compound is the Jamieson Fire-Resisting Paint Co., 62 and 64 William St., New York.

THE MOORE DIFFERENTIAL PULLEY BLOCK.

In the installing of new machinery about mines, or in making the ever recurring repairs, if the work is to be done with celerity and ease, some convenient means of handling heavy weights, better than the devices usually found in such places, can be used to advantage. The simple block and fall needs contant attention to prevents its running back when hoisting, to say nothing of the need of frequent renewal of ropes, and some of the older types of the differential pulley block have excessive friction, making the work of hoisting slow and difficult.

One form of differential pulley block recently brought out by the Moore M'f'g. & Foundry Co. of Milwaukee, Wis. possesses, it is claimed several points of superiority over any other form of this device. From a circular issued by the manufacturers we adapt the following description of the peculiar advantages and construction of the device.

The leverage in this new Moore Block is obtained by a gear and pinion movement. As shown in Fig. 1, the pinion is double, that is, two sizes in one casting. Referring to Fig. 1, and noting the point "A" in the center of the eccentric, the point "B" directly below it on the pitch line of the smaller pinion, and the point "C" below and in line with the other two points on the pitch line of the larger pinion—the line on which are these three points is the lever. The fulcrum is an imaginary point "F" on the line of the lever, midway between the pitch lines of the small and large pinions.

Fig. 1.

Fig. 2.

The annulars, Fig. 2, or internal gears, are in mesh with the two pinions (or double pinion) at points "B" and "C" on the above named lever. The lever operates on the annulars at these points; and, since the lift chain hangs from opposite sides of these annular wheels, they are pulling in opposite directions, one on each side of the imaginary fulcrum, point "F." Now, turn the eccentric slightly, the lower part to the right, imagine the fulcrum point "F," stationary, the point "A" of the lever moves to the right, the point "B" of the lever will move in the same direction, but the point "C," being on the other side of the fulcrum, will move in an opposite direction; the two points, "B" and "C," necessarily carrying with them the annular, or lift chain wheels, in opposite directions.

Fig. 3.

It will readily be seen that whatever the position of the eccentric and pinion, the relative position of this imaginary line, or lever, is always the same.

It is rather an infinite series of levers, corresponding in number with the number of points on the pitch line of the annular wheels.

It is apparent that the load on the block exerts through this leverage a constant pressure on the side of the eccentric, and that the block will "run down" unless there is sufficient friction to prevent it. Such friction is secured by means of the automatic brake, illustrated in Fig. 3

A friction plate "F" of slightly less diameter than the hand wheel is mounted upon an extension of the hub of the hand wheel and between it and the block frame "A."

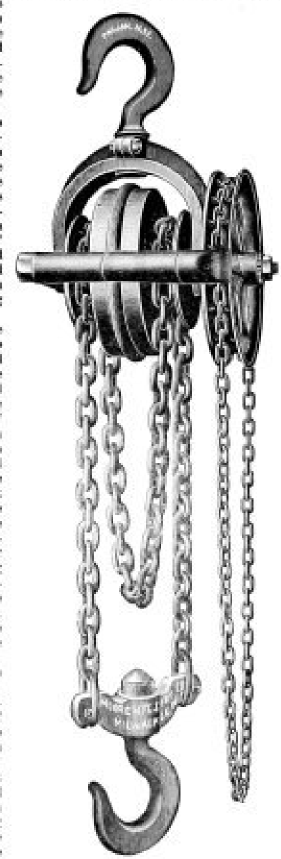


Fig. 4.

The friction plate has a wedging contact with the block frame at "B," and the hand wheel has a reverse wedging contact with the clutch "D," which is keyed to the shaft and held in position by the adjusting nut "E."

A pull on the hand chain to raise the load loosens the wedge "B" and tightens the wedge "D," while a pull on the hand chain to lower the load tightens the wedge "B" but loosens the wedge "D," one wedge counteracting the other and producing no friction between the plate and the frictional surface of the wheel at the point "F."

But when the hand wheel "G" is in a state of inertia, the pull of the load on the shaft tightens the wedge "D," carrying with it the hand wheel and friction plate, tightening also the wedge "B," and the two wedges acting together set the frictional surfaces into contact and effectually lock the block. A pull on the hand chain in either direction releases one of the wedges, but as soon as the pull ceases the load instantly catches up and locks both of them. The lock is positive and smooth working, since the friction surfaces are really never out of contact, and heavy loads may be lowered by a pull on the chain of a very few pounds.

The block with all parts assembled and ready for use is clearly shown in Fig. 4.

By the construction shown friction is almost wholly obviated, and a smooth working, serviceable device has been produced. The block is made in various sizes, ranging from ½ ton to 10 tons capacity. The manufacturers will be pleased to furnish to mine operators and managers any further information as to prices and sizes desired.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

Gyration and Percussion.—Mean Effective Radius of a Fan.—The Calculations for Efficiency.—Radius of Gyration of Discs and Rims.

61. Gyration and Percussion.—The mode of action of the centrifugal variety of fans is full of interest to the student of mining, and in the fore-front of the investigation there are certain elementary principles in mechanics that must be known, or otherwise progress is impossible; first then let us determine the radii of gyration and the centers of percussion that will have to be sought for and found in the solutions of fan problems.

First then what is meant by the term "radius of gyration"? To make the matter clear let us take for an example a straight bar of uniform section, and find out what will occur if it is made to revolve or turn on one of its ends. With the aid of Fig. 107 the bar in question is supposed to be in the act of turning on one of its ends as at O, while the end P, describes an arc of a circle. It will be further seen, that points all along the bar from O to P, move at different velocities, and these velocities are directly proportionate to the distances of the points from O; or beginning at O, and travelling along the bar to P, the velocities for the uniformly increasing distances are 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Each of the equal divisions of this bar of uniform section will be equal in weight, to each and all of the other divisions, therefore we will call the weight of one division 1. Again although the divisions are equal in weight, the energy stored up in each is different the moment the bar begins to turn on O; for we are confronted again with that principle in mechanics that is met with so very frequently in mining, namely, the energy stored up in moving bodies "varies as the squares of the velocities," consequently all along the bar from O to P the energy in each point is as follows, the top line of figures representing the velocities and the under line the energies, as

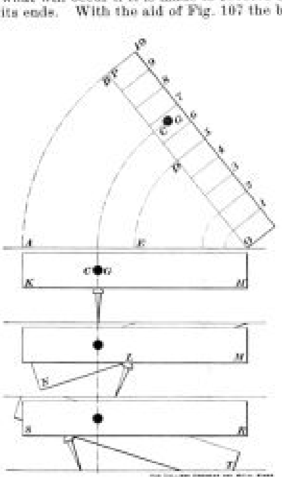


FIG. 107.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
1, 4, 9, 16, 25, 36, 49, 64, 81, 100.

For example, the point 10 moves through a distance equal to the arc AB, while the point 5 moves through an arc of half the length as ED. The energy stored up in the particle 10 will then be 4 times that stored up in 5, because $\frac{10^2}{5^2} = \frac{100}{25} = 4$. Taking the energy of the particle 1, for unity of measure, then the sum of the energy stored up in all the particles as a whole will be in the proportion of the sum of the squares of the distances of the particles from the center of motion: and let us here notice that the distances 1, 2, etc. are not so exactly proportionate to such distances as would correctly represent the value required; for example, the first divisional piece is 1, but one end of that piece has no velocity, because it touches the center of motion; the mean velocity then of the center of gravity of that piece is .5 and the mean velocity of the piece 10 is therefore 9.5, but for the present, to avoid fractions that would becloud the explanation, let us take the remote distances 1, 2, 3, etc. The velocities can then be represented by the distances along the radius, because the linear velocity varies directly as the distances of the particles from the center of motion, and the energy stored up in each particle varies directly as the squares of the distances from the center of motion; and to still further make the matter clear, let us repeat the relationship of motion to energy by two lines of figures which in the first case represent the distance of the particles from the center of motion as before, and in the second case, the energy due to the velocities generated by the distances 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 from O in the figure.

Energy stored up as the result of the different velocities of the particles 1, 4, 9, 16, 25, 36, 49, 64, 81, 100.

The total energy or the sum of the energy in the particles is

$(1 + 4 + 9 + 16 + 25 + 36 + 49 + 64 + 81 + 100) = 385.$

This sum is, as we have already shown, too large, because the distances were extreme, but the number 385 can be corrected by a constant number .891288 as $385 \times .891288 = 343.14588$.

We are now in a position to find the radius of gyration, so important in fan calculations; that is the length of a radius whose revolving end or extremity would move with such a velocity, that if all the matter in a bar of uniform section could lie in the point just named, and the bar continued to have the same angular velocity as before, the units of energy would continue to be equal to 343.14588. To find the radius of gyration in this case we must first find the mean energy per unit as $343.14588 \div 10 = 34.314588$. Now we saw by the explanation that the energy in each particle along the bar was proportionate to the square of the distance from the center of motion, therefore the length of the radius of gyration in this case must be $\sqrt{34.314588} = 5.8578$. That is to say if a uniform bar 10 inches, 10 feet or 10 yards long, was made to turn on one end, the energy stored up in it would be the same, as would be stored up in the same weight of matter, all gathered together in one point situated at 5.8578 inches, feet, yard, miles, etc., from the center of revolution. From the radius of gyration we can determine the position of the center of percussion another point of great importance in fan calculations. This point divides the energy stored up in a uniform bar turning on one end, into two equal forces, and as we now know that the energy in the particles of this bar are different, we conclude, that the center of percussion will be nearer the rapid moving end; and taking the length of such a bar to be 1 inch, 1 foot or 1 yard, or one any other unit of length in length, we find the center of percussion to be one-third of the length of the bar from its rapid moving end. Now the terminus of the radius of gyration is .58578 of the length of the bar, from its center of motion, and therefore the complement of the length of the bar is $1 - .58578 = .41422$. Now the square of the radius of gyration is twice the square of its complement, and therefore these squares are exactly proportionate to the short and long ends of the bar, as measured from the center of percussion. The number 12 may be taken to illustrate what all this means. Now let a 12 inch bar turn on one end, then the center of gyration would occur at 7 inches from the center of motion, because $12 \times .58578 = 7.02936$ but leaving out the small decimal part, 7 inches is a very near result, and therefore, 5 is the complement, or the number to be added to the radius of gyration to make up the length of the bar. The two portions of the bar that lie in opposite sides of the center of percussion are to each other as,

$$.41422^2 : .58578^2 :: 1 : 2 \text{ or } \frac{.58578^2}{.41422^2} = 2.$$

Again you only have to remember that the center of percussion is situated at a distance of one-third the length of the bar from its fast moving end to find the equivalent of the radius of gyration or the number .58578, because this radius and its complement are to each other, as the square roots of the two distances from the center of percussion. Now the axial lengths from the center of percussion, can be used as factors to determine the value of the fractional multiplier for finding the length of the radius of gyration in any given case as

$$\frac{\sqrt{2}}{(\sqrt{2} + \sqrt{1})} = .58578,$$

the relative length of the radius of gyration.

In the figure before us is given an illustration of the importance of this point called the center of percussion; for example, if a bar turning on one end, strikes a nail head immediately under the center of percussion, the nail will advance plumb into the wood, as in the case $K H$, where CG is the center of percussion; should however, as in the case NM, a point L within the center of percussion strike the nail head, the excess of energy at the N side of the nail head, will cause the bar to advance and drop as shown at N, and in spite of care, the nail will incline in towards the center of motion. Again in the case of $S R$, if the bar strikes the nail head without the center of percussion as at S, the excess of energy within the center of percussion will cause the bar to drop as at T, consequently the nail head is thrown off as at S.

Sometimes the mass revolves about the center of motion without reaching to it, as illustrated by Fig. 108, and here we see that the center of motion is situated at O, and from O to a measures 6 feet, and that a to m measures 6 feet say. The velocities are proportionate to the radial distances as ab, cd, ef, gh, ij, kl, and mn and to find the radius of gyration in a simple and easily understandable manner, let us find the mechanical moments with the mean distances 6.5, 7.5, 8.5, 9.5, 10.5, 11.5; then $(6.5^2 + 7.5^2 + 8.5^2 + 9.5^2 + 10.5^2 + 11.5^2 = 503.5$. Now the mean number of mechanical moments can be found by dividing the sum by the number of particles as

$$\frac{503.5}{6} = 83.916,$$

and as before the radius of gyration will be equal to the square root of the mean number of mechanical moments as $\sqrt{83.916} = 9.16$.

62. Mean Effective Radius of a Fan.—The lower portion of the figure is to show that the energy within a fan due to the centrifugal force is confined to the annular space whose radial depth is equal to $r p$, or $q s$.

By the arrows on the outer circle the fan is seen to revolve, left about, and by the radial arrows it is intended to be shown, that the air passing through a fan flows along the front of the advancing blades, and the result is the energy must be determined by the mean radius of gyration situated between r and p or q and s.

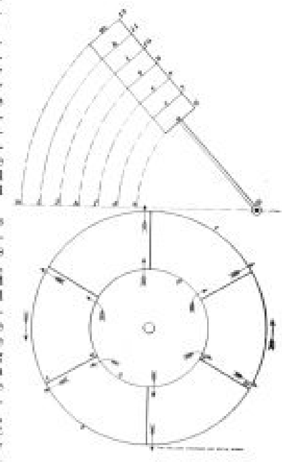


FIG. 108.

63. The Calculations for Efficiency.—It will require several lessons to explain the mode of action, and how to determine the work done by a fan, but if the reader will take care to secure these introductory facts and explanations, it will make the work in the final calculations easy, indeed it is our aim to so explain the fundamental principles, that the reader can antedate the conclusions.

64. Radius of Gyration of Discs and Rims.—Fig. 109 is given to show that the radius of gyration for

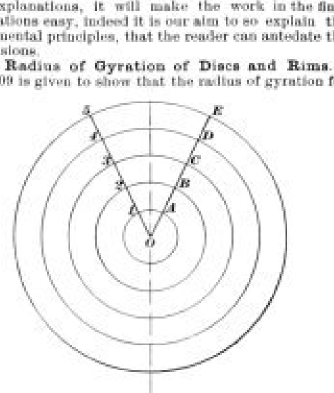


FIG. 109.

a solid discoid wheel, or for the rim of a fly wheel is found not by the squares, but by the cubes of the radial distances, and the reason of this is clear, when you consider that the mass in each annular division along the radius increases directly as the radius; for example, the matter in the ring 2 B, is twice that in the ring 1 A, or the matter in the ring 4 D is twice that in the ring 2 B. Consequently for annular masses such as the rim of a fly wheel, we proceed to find the area of gyration as follows: Taking the figure of a wheel A B D as an example, here the radius of the inside of the rim is 8, and the radius of the the outside of the rim is 9, then

$$\sqrt[3]{\frac{(8.5^3 + 9.5^3)}{2}} = \sqrt[3]{\frac{(614.125 + 857.375)}{2}} =$$

9.08 = the radius of gyration.

Fig. 110 illustrates first the angular velocities of the points A, B, E and F and this sketch is further intended to show that the motive column in a fan supplies force for a three fold purpose;

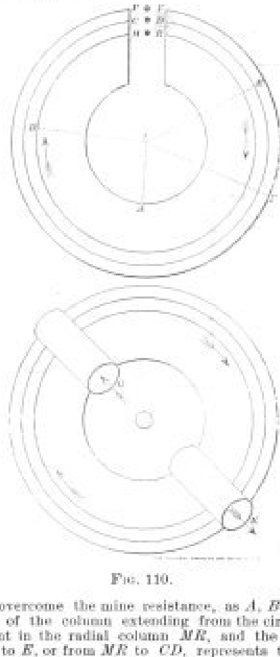


Fig. 110.

first to overcome the mine resistance, as A, B, or that portion of the column extending from the circle A to the point in the radial column MR, and the column from B to E, or from MR to CD, represents the proportion of the column that gives motion to the air blowing into the fan, and the depth of the column from E to F, or from CD to PV, represent that portion of the motive column that is expended in blowing the air out of the fan: the distances require however to be qualified by the differences in the linear velocities in the proportions LA, LB, LE, and LF. At G and K the figure draws attention to a matter that will still further engage our attention, namely, that the orifice of inlet into a fan should be equal to the orifice of outflow, and that the area of K should never exceed the area of G. Fig. 111 illustrates the characteristics

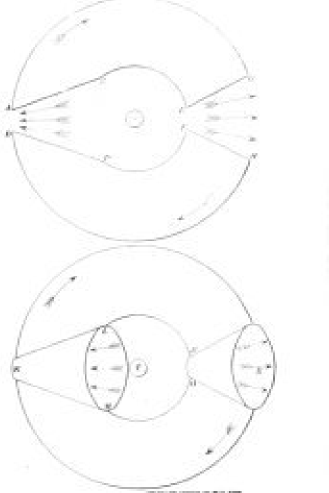


Fig. 111.

of the two classes into which fans are divided, namely the low and high pressure varieties. The orifice of entry at CD and LM is so large in proportion to the orifice of outflow, that the conical constriction causes no acceleration of the air at discharge and thus wastes the energy of the fan, unless the mine resistance is high as in the typical encased fan. In the case of the open running fans the diffusion as indicated by the arrows at G, H and R will be shown to be a mistake. The Figs. 110 and 111 are given for frequent reference in the future articles explaining the processes involved in fan calculations.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

The Action of Commutators.—Electric Impulse.

60. **The Action of Commutators.**—We saw in our last lesson that the magneto-electric currents, or the electricity induced by magnetic action, was alternate in direction; that is, it was alternately positive and negative during the revolution of the armature, and we repeat again that magnets can only be used to generate alternate currents, for at make and break the electric pulsations are positive and negative in direction as all our previous lessons have shown.

Where, however, a continuous current is required a commutator is made to give continuity to the external portion of the circuit: and to make the use of this current director understandable Fig. 102 is

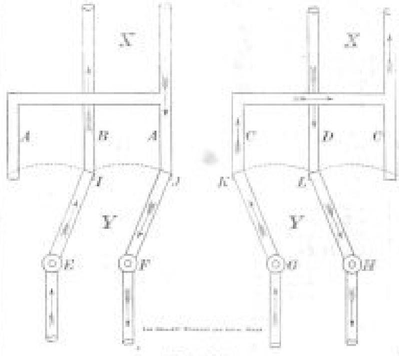


Fig. 102.

introduced. The internal portion of the circuit that constitutes the solenoids of the magnets, or the coils of wire on the magnets, is always the path for alternating or polyphase currents; then let us suppose that X, X is the internal or solenoid portion of the circuit that is alternate through the cables C D or A B and that G H and E F are the terminals of the external circuit that convey the current for lighting or motive energy as Y and Y. It will be seen by looking at the cables C D and A B, that they are just two examples of the same cables, and that the directions of the outgoing currents H and F are alike, and also those of the return currents G and E; this continuity of the currents in the same direction is secured by the action of a commutator. There really are no commutators applied to magneto electric machines or dynamos, like the one before us, but this example furnishes the best illustration of what a commutator is, and enables us afterwards to understand the more complex arrangement.

Now it will be seen that branch connections from C and A are marked like their stem A and C, and it is further seen that two contactors L H and K G, or J F and I E, turn on hinges E, F, G and H, and when the the current from the coils of the dynamo has adirection such as D and C, the contactors are turned over to make contact at K and L, and when the induced *alternate* current, has the outgoing and return directions of B and A, the contactors are moved over to I and J, and thus by the alternate movements of the contactors, first to the right and next to the left, the external current outgoing at F and H and returning at E and G

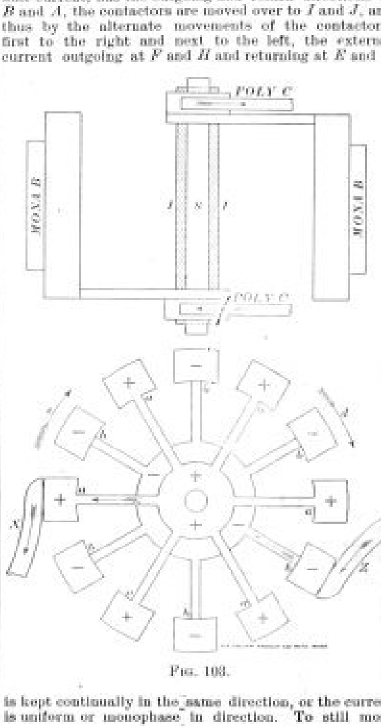


Fig. 103.

is kept continually in the same direction, or the current is uniform or monophase in direction. To still more clearly explain the commutation on a dynamo, Fig. 103 has been designed.

The shaft S being a metallic conductor, it is necessary that the commutator be insulated where the boss carrying the opposite sections is keyed over the shaft, a sheave is also keyed over the shaft as a fixed portion of each boss. The wood insulation is seen in section at I I and the shaft at S. A spring connection rests on each sheave, and these are intended to contact for the outgoing and return ends of the wires from the generator coils; the result is, they are polyphase, or they are the channels for the passage of alternating currents as Poly C, and Poly C. The lower portion of the figure is not a drawing of a commutator, but a design to explain its use, and if the reader can comprehend the principle of the construction and mode of action of this figure, he will never fail to understand the commutator in its completeness; and let us notice that this instrument is one of the marvelous productions of human genius, and its function is that of a regulator or director of the continuity of the electric current, and is therefore allied to the continuity regulators, such as the intake and delivery valves of a pump, or the steam and exhaust valves of a steam engine. We have already shown how the two sets of contactors are insulated from each other, and now to make the illustration unmistakably clear, the insulated contactors are seen to be attached to or to spring from different discs at the center of the wheel, the large one is marked — — and the small wheel is marked + +. All the contactors connected with the small disc are lettered a, and all the contactors connected to the large disc are lettered b. As we now know the current is produced in impulses at the moments when the polarity of the magnets is greatest and least, and these opposite conditions of induction generate alternately positive and negative impulses in regular order and succession, and this being so the commutator is made to sychronize these impulses in such a way that at the precise moments when the magnets induce a positive electric wave in the coils of the armatures, the contactor touching X is positive, and the one touching Z is negative, and all the b contactors become a or positive on reaching X and all the contactors marked a become b or negative on reaching Z. Or in rapid succession the a's are changing to b's, and the b's to a's, or every twelfth of a revolution the contactors are changing from positive to negative, or from negative to positive, but the change takes place in such order, that as each contactor arrives at X it is a or + and as each arrives at Z it is b or —. The brushes on a commutator as X and Y or Mona B and Mona B in the upper portion of the figure, are for sweeping off the positive electricity and returning the negative of the circuit, hence the continuity of the current.

61. **Electric Impulse.**—Fig. 104 is an illustration of electric impulse; here a rocking lever d, turning on the axis c, and moving rapidly with the hand on the

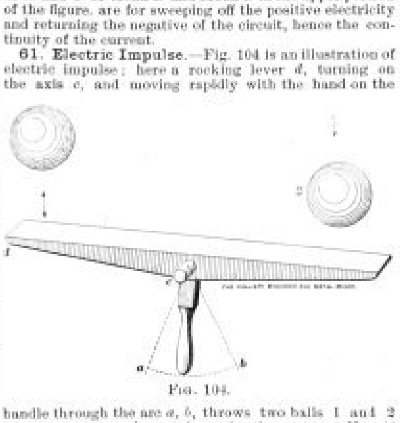


Fig. 104.

handle through the arc a, b, throws two balls 1 and 2 alternately upwards as shown by the arrows. Now if after every toss of a ball, the lever was turned in a horizontal plane through half a circle, the same end of the lever could be made to knock both the balls upward, and in that case we would have the the exact analogue of the commutator in so far as the mode of action is concerned, but this lever and balls also illustrate another characteristic of electricity that will just now concern us, and that is electrical pressure, tension, or voltage: for example, the higher the velocity with which the balls are thrown off the ends of the lever the greater is the elevation to which they will rise, and as the energy stored up in each ascending ball will vary

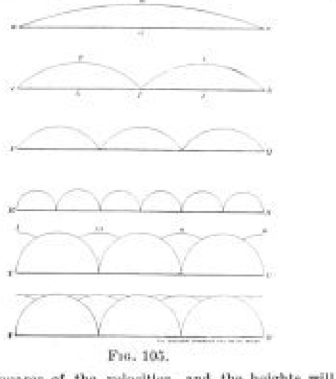


Fig. 105.

as the squares of the velocities, and the heights will vary directly as the work, these balls furnish an illustration of the pressure of an electric wave as illustrated by Fig. 105, and here the height or voltage of the wave is shown at *b d*, but the breadth of the wave *a c*, indicates a low progressive velocity, or the armature is running at a low speed. At *e k*, the voltage has increased as at *g h*, or *i j*, because the speed of the armature has been doubled as shown by two waves, *P Q* is an illustration of intermitting impulses at long intervals, and *R S* shows distinct impulses at shorter ones, but at *T U* an approach to uniformity in the pressure or voltage of the current is made by overlap waves, and at *V W*, the electrical swell of tension or voltage, is made to approximate a continuous level, by a double series of intermissions, and by this means a mere pulse or succession of outbursts, is converted into a steady even flowing electric stream.

[TO BE CONTINUED.]

GEOLOGY OF COAL.

Life of Silurian Times.—Carboniferous Fossils.

49. **Life of Silurian Times.**—The fossil records of the Silurian period, in so far as the imprints of marine life are concerned, show that it was as prodigious and varied as the life in our seas to-day, and yet these protozoic organisms were only prototypes of the higher organisms of the higher environments of all the succeeding periods.

The Silurian period is noted for its immense fauna and its almost unwritten page of examples of its flora. Nearly all that we know of its plant life relates to thallogens, or the most lowly vascular cryptogams and fucoids, or weeds of the sea.

We can hardly entertain the conclusion that the dry land of the period was a lifeless waste, because the plant forms that we have found imprints of, con-

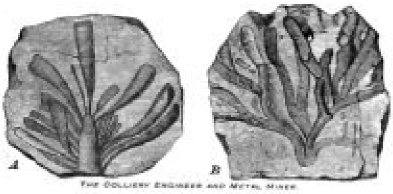


Fig. 80.

tinued into the succeeding Devonian period, where we find them along with the highly organized coniferous trees, that have continued with little alteration through all the mighty ages and changes, until they are our pine trees of to-day. Why then are so few evidences of a profuse flora found in the lamina of the Silurian rocks? An answer to this question we cannot give, but we rest assured that the childhood of the coniferous tree, even antedated the Silurian period. Fig. 80 furnishes two examples of fucoids, or sea weeds. Now this may furnish a cue to knock the ball along, for we know that the animal life of the sea could not exist without the prime source of his nourishment. In the order of nature, plants alone appropriate inorganic matter, and build up out of it organic tissue, animal life cannot be nourished by inorganic matter, and therefore a vast number of animals derive their life supplies from the consumption of organized vegetable tissue, and the vegetable eaters in

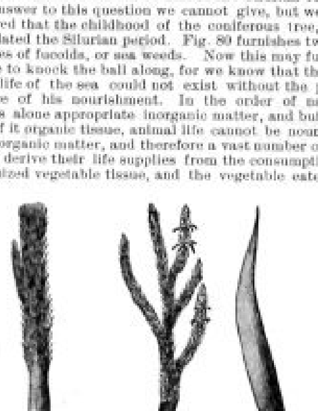


Fig. 81.

their turn become the food of the carnivora, but the great fact remains, namely, that plant life is the prime source of the sustenance of all animal life; if then evidences of animals on the dry land can be found, other than fish eating examples, we may be sure that a supply of vegetable food was accessible. Now in the upper Silurian a fossil scorpion has been found, and this carnivorous insect could only obtain its food by devouring other insects, that obtained their food from the fruits, leaves, bulbs, and roots of relatively highly organized plants.

From all this we learn that the positive indications of Silurian strata are the primitive life forms, such as graptolites among zoophites, brachiopods among mollusce, and that the negative evidence is of a decisive kind, namely the almost entire absence of plant remains. So much is this the case that the prospector for coal can at all times determine with precision the presence of Silurian rocks.

The Devonian that succeeds the Silurian, is teeming with evidences of a stupendous advance both in variety and development of a highly developed fauna and flora, for plants now furnish positive instead of negative indications of the presence of the Devonian strata; and strange as it may appear, the Devonian flora was not only the immediate precursor of the Carboniferous flora, but of the horsetails and conifers of to-day.

The ferns and other aerogens of the Devonian period are however of a more lowly type than those of the Carboniferous period. Fig. 81 furnishes examples of the sigillaria of the Devonian period, and but for the immature organic development which the imprints indicate, they might be mi-taken for Carboniferous fossils. In the figure at *A* and *B* we have the sigillaria as a tree and at *C* an enlarged view of one or its bracts or leaves, at *D* we have a fossil imprint of a portion of the stem of this primitive tree that contained the embryo of the conifers or pines. Fig. 82 furnishes at *A*, *D* and

Fig. 82.

E some examples of Devonian ferns, and it will be seen that their fronds or leaves have a structure and variation characteristic of the period, but far short of the higher development of the fronds of the ferns, that characterize the Carboniferious period. At *B* and *C* are examples of embryonic, lepidodendra.

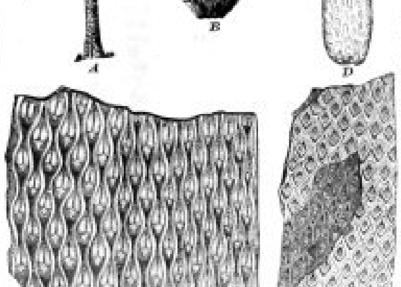


Fig. 83.

50. **Carboniferous Fossils.**—Figure 83 shows lepidodendra of the Carboniferous period, at *A*, a restoration, and at *B*, *C*, and *D* the seed or spore cases of the plant. It is only in Australia and in tropical countries in Asia, that tree plants allied to the sigillaria and lepidodendra are now found, and stranger still, a small acrogen grows in Europe that is a dwarf example of these singular trees. The lepidodendron is the forerunner of the sigillaria and the sigillaria is the immature pine, or the forerunner of the conifers. At *E* and *F* we have fossil imprints of the stem of the lepidodendron.

Figure 84 is an illustration of the horse-tails or true rush trees of the Carboniferous period and known under the general name of calamites. These peculiar plants

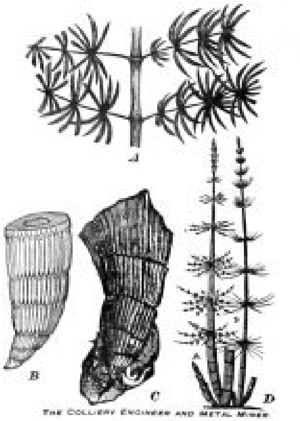


Fig. 84.

are the forerunners of the endogens or the grasslike plants of our day, as common grass, wheat, oats, barley and many such like plants, along with canes and bamboos. How interesting then must be the study of economic mining geology, when we discover that all the plants that distinctively characterize the Carboniferous formation had in embryo, the germs out of which the highest types of their successors have been developed. At *B* and *C* we have fossil examples of the root end of the stem of the calamites, and at *A* we have a piece of a stem of the plant, showing the nodes or knots from which the bracts spring. At *D* is a view of the plant while living and growing. All the fossils of this plant found are flattened and lying horizontally on the beds of the strata, just as a large hollow reed growing in water would do at the period of decay.

[TO BE CONTINUED.]

MINING METHODS.

The Velocities of Air Currents—Measurement of Current Pressure.—Water Gauges in Action.—The Advantages of Tube Gauges—Improved Types of the Water Gauge.—False Reading of Water Gauges.

56. **The Velocities of Air Currents.**—The volume of air circulating in a mine, or the measure of the ventilating current in cubic feet per minute, was first determined by finding the time required for a cloud of black smoke to ascend the upcast or furnace shaft of a bituminous mine in England and the mode of proceeding was as follows: Two observers with their watches set exactly alike were stationed so that one was beside the furnace in the mine to note the second of time at which "small" coals were thrown on the furnace fire, and the other was stationed at the surface to note the exact time at which the cloud of black smoke arrived.

The difference of the times of the two observers, was the time of the ascent of the smoke in the shaft. The depth of the shaft and the diameter being known, it was easy to determine the cubic feet of air per minute in the ventilation of the mine; and to make the matter clear let us suppose the diameter of the circular shaft was 10 feet, and the depth to the furnace 600 feet, and the time of the ascent of the smoke 40 seconds, then the velocity of the air current in the shaft, in feet per minute is

$$\frac{600 \times 60}{40} = 900.$$

The area of the circular section of the shaft is $10 \times 10 \times .7854 = 78.54$ square feet, and the volume of the ventilation in cubic feet is $78.54 \times 900 = 70686$.

57. **Measu ement of Current Pressure.**—At the time under notice the current pressure was not measured, but when the current was moving quick the miners used to speak of the "force of the wind" and at last the inquiry was, what can that force be? and then attempts were made to measure it. The so-called water gauge was first used by the engineers of gas companies to measure the super-atmospheric pressure of the coal gas in the "mains." The pressure in gas mains is various according to the extent of the distribution and the grades on which the pipes are deposited, and the elevation of the supply tanks. As the distribution of coal gas through pipes brings before us the operation of many natural laws that concern us in mining, just let us notice some of them, first then, when the gas tank is situated at an elevation of 450 feet above the level of distribution, it requires a pressure of 3 inches of water gauge to sink it to the low level of the city, for if a cubic foot of air weighs .077 of a pound, a cubic foot of coal gas will weigh .03465 and $.03465 \times 450 = 15.5925 = \frac{15.6}{5.2} = 3$ inches of w. g. Second, as the area of the transverse section of the pipes is small, the current friction is considerable, and would be so great

as to require a high pressure to send the gas through many miles of pipes, but for the splitting that takes place. First we have the splits of the first degree in the great mains, and then the district mains, or splits of the second degree, and next the street mains, and then the splitting, and splitting, and splitting until the splits are of hundreds of degrees before the gas reaches the burners, the result is the current friction is very much reduced, and yet the pressure to force gas through the pipes ranges from 5 to 25 inches of w. g. *miners measure*.

The gas engineers do not reckon the pressure per square *foot*, but per square *inch*, and they coined the term water gauge, and the miners have followed suite.

58. Water Gauges in Action.—Figure 105 is an illustration in vertical section of the earliest miners water gauges. The instrument consisted of two parts, the tank *T*, and the vertical glass tube *G*. This tube was bent at the top to allow the instrument to be connected with the low pressed air, on the negative or *M* side of the stopping or door, as *M* on the left hand side of *XY*. The lower end of the tube entered the bottom of one side of the tank *T* on the positive or current pressure side of *XY*, as *P* +. The gauge was used to measure the inches and tenths of an inch in the elevation of the water column in the glass tube, or the height of *a b* above the level *c d*.

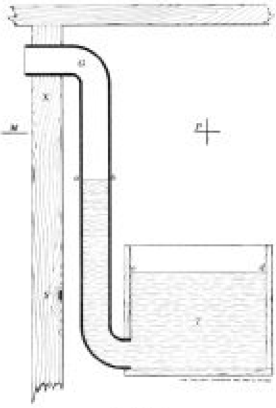


Fig. 105.

This variety of the water gauge was considered inconvenient and unsightly, and was therefore substituted with bent glass tubes as in Fig. 106.

59. The advantages of Tube Gauges.—These tubes are convenient and portable, and can be carried in a side-pocket, and if the bent ends are fixed in a cork, they can be tried on a door or stopping without the waste of much time. If you desire to make a gauge, 18 inches of glass tubing about an eighth of an inch in the bore, and of the variety easily softened in the flame of a gas-jet, can be purchased for 10 cents, and the bending is easily done by a novice, the result is, no mine foreman need be without a gauge for determining the current pressure. Two gauges are fixed on opposite sides of a wood stopping, with the view of illustrating, how the water column in one leg of the gauge is depressed, while that in the other is raised, and let us notice that the limb on the super-pressure side is always depressed as *K* and *G*, because they are on the *P*, or + side. The two figures furnish a good illustration of the square inch, and square foot modes of measuring current pressure, for let the cistern or tank *T*, Fig. 58, have a top surface as extended as the surface of the ocean, or let it measure a square inch or a square yard, the same difference in pressure between the *P* and *M* sides of the diaphragm *XY* would produce the same difference in the levels *a b* and *c d*. It will be seen by the figure that the leg of the gauge on the low pressure side of the stopping contains the highest water column as at *H* and *E*. The difference of the levels *a b* and *c d* means that a slab of water one foot square in the base, and 2 inches deep, say, is equal in weight to the pressure that is producing ventilation. Now such a slab of water will weigh 10.4 pounds because if a cubic foot of water weighs 62.5 pounds, that is if a slab of water 1 square foot in the base and 12 inches deep weighs 62.5 pounds, then 2 inches must weigh one-sixth of that and $62.5 \times \frac{1}{6} = 10.4$ pounds. The pressure producing ventilation is reckoned per square foot, the pressure however is not altered by the unit of measure because it might be represented as pressure per square inch after the custom of the engineers of gas works, now the unit in mining is found by dividing a cubic foot of water into 12 slabs, each an inch *thick*, that is $\frac{62.5}{12}$

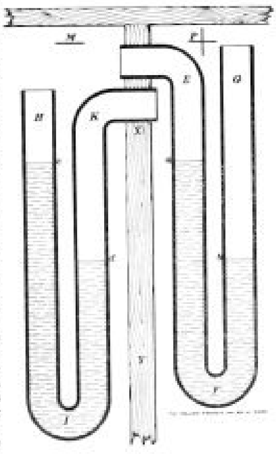


Fig. 106.

$= 5.2$. The gas engineer takes for his unit of weight 1 inch in depth, and 1 square inch for his base, or in short the weight of a cubic inch of water which is equal to $\frac{5.2}{144}$ or $\frac{62.5}{1728} = .03611$ or .036.

60. Improved Types of the Water Gauge.—Fig. 107 introduces to us the improvements that experience rendered necessary in the construction of the water gauge.

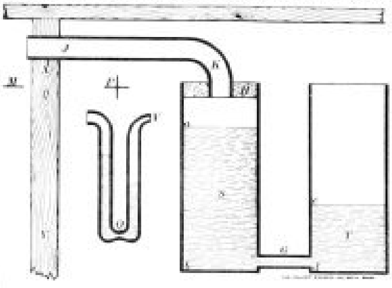


Fig. 107.

When Cook's rotary pump and Nixon and Strauve's reciprocating pumps were introduced as mine ventilators, it was found that the water gauges in use could not be used to find the pressure of the ventilating currents, for at every throw of Cook's eccentric drums, and every stroke of Nixon and Strauve's pistons, the water columns in the legs of the gauge oscillated so much, that no reading could be taken, and therefore special gauges had to be made. The chief improvement secured by the Daglish patent was the contraction or reduced orifice at the *U* bend of the tube, as that shown at *Q*, for when the current pressure was rapidly fluctuating, the water could not flow responsively through the contraction, and the result was a mean reading.

But for ventilating pumps, the gauge shown at *S T*, is the best in practice. Here large square glass chambers are connected as *S* and *T*, by the small connecting tube *G*, and the result is, the pulsating or throbbing current, does not prevent a correct reading of the ventilating pressure.

The differences in the head levels of the water columns in the large tubes are as a matter of course, the same as those that would be indicated by small ones. At *V*, the *open* leg of the gauge is contracted to prevent evaporation and the entry of dust. At *H*, the branch tube *J K* passes through an air tight cork at the *K* end, while the *J* end is fixed in the stopping *X Y*. The gauge may be read as in all other cases by the height between the levels *a* and *c*, or the difference of the heights, *a b* and *c d*.

61. False Readings of Water Gauges.—Fig. 108 is given to show how inaccurate indications of the mean current pressure arise. The variations in the gauge that produce false readings, are the result of the manifestation of inertia arising from deflections and displacements in the path of the current. To prove this, partly fill a bottle with water, and introduce through the cork a T pipe as *d*, *m*, *j*, *q*, the connection of *j q* with *d m* is made with a small contracted orifice at *j*, and a contracted mouth piece at *m*. Now the cork must not fit air tight into the bottle neck. If you blow a good blast through the mouth-piece *m*, the current in the tube *d m*, sweeps over the orifice at *j* and produces at that opening a partial vacuum by displacement, the result is, the water rises up the leg of the tube *j q*, and when it reaches *j*, the blast of air cuts off the head of the uprising water, and intensifies in this way the vacuum. The same mode of action sometimes seriously effects the reading of water gauges; for example, this is explained by a study of the entering tubes *A*, *B* and *C*, which are connected with water gauges through the side of a fan drift, and the current is blowing right onto the open orifice of *A* at *K*, here the false reading is a greater pressure or falsely increased pressure, as the result of the inertia of the arrested particles of moving air. At *B* the air is seen to sweep past the open orifice at *G* and thus produce a depression as in the case of the pipette on the bottle. At *C*, the air is seen to blow from the orifice at *D*, and thus make a partial vacuum and consequent depression of the gauge. To correct all this, the connection of the gauge with the drift has to be wisely made. Fig. 109 shows two examples of false readings arising from deflections of the air currents. The first drift has a right angle elbow, and the reading of a gauge connected at *A* is too small, as the result of the inertia of the impinging air striking the reflecting side of the drift. A gauge connecting at *B* is not reliable, and strange to say a gauge connected at *C* gives a higher than the true reading and is most unreliable, because the deflected air not only produces a depression at *C*, but the wave impulse of the agitated air makes the *C* reading very unsteady.

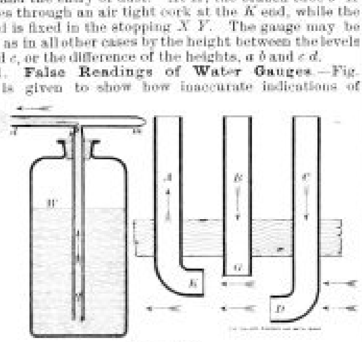


Fig. 108.

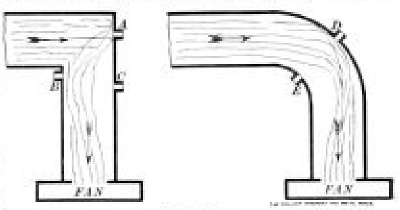


Fig. 109.

In the same way the depression at *E* will be greater than at *D*.

(TO BE CONTINUED.)

LONG DISTANCE POWER TRANSMISSION.

The Utilization of a Splendid Water Power by Aid of Electricity.

An interesting long distance power transmission plant is in course of construction at Fresno, Cal., which is unique in more than one particular. The head of water to be used is 1,410 feet and the distance of transmission about thirty-five miles. The natural conditions surrounding the installation are extraordinary in themselves. The water for supplying the power is taken from the North Fork of the San Joaquin river. The stream of the North fork runs for several miles down a rocky canyon, forming rapids and cataracts as it runs between the steep mountains. At the head of the rapids a canal will take the water out upon the summit of a high ridge, which it will follow for six miles to a point nearly fifteen hundred feet above the San Joaquin river. Here a reservoir has been constructed with an average depth of ten feet. It covers about eight acres and can be made both larger and deeper, should the demand for power require an extension. Into this reservoir, the water brought along the ridge by the canal will be stored, but it will be used solely as an emergency store. It is calculated that it will hold enough water to drive the machinery for several days, so that should a break occur between the reservoir and the source of supply, the electrical work could continue until the repair was effected.

A pipe line runs directly from the canal a distance of about four thousand feet to the power house, and the head of water obtained will not be less than 1,410 feet. The pressure at the bottom will be six hundred lbs. to the square inch. The lower end of the pipe line is of welded steel pipe, three-quarters of an inch in thickness, having special steel flanges and special packing at the joints. The lowest amount of water power available is at least 7,000 H. P. at the head above mentioned. All possible accidents are provided against. Should a break occur near the lower end of the pipe the rush of water would form a vacuum near the upper portion of the pipe and it might collapse under atmospheric pressure. An air valve will be placed near the top to provide against this contingency. The pipes will be made in sections of twenty feet each. At the upper end the metal will be ¾ inch thick and the pipe 24 inches in diameter. It will be fastened to the solid granite mountain sides by steel cables.

The power station will be located at the bottom of the mountain, and will contain three Pelton water wheels 58″ in diameter, driven by a single nozzle. The generating plant will consist of three 340 K. W. General Electric Company's three phase generators. The three phase system has been selected in this case as the system which will give the highest efficiency of transmission with the lowest cost of copper.

From the point in the North Fork of the San Joaquin river, where the water is taken to the power house at the foot of the mountain, is a distance of about seven miles. From the power house to Fresno, where the electricity will be utilized is about 31½ miles in a direct line, or 35 miles over the electric wires. The line will consist of two circuits of bare copper wire, consisting of six wires strung on poles forty feet high. The current will be delivered to the lines at a voltage of 11,000 volts. From the power house the line will rise to the level of the San Joaquin, cross it and pass through a portion of the Auberry Valley, then rising over the Red Mountain, passing about a mile west of Clovis will continue direct on to Fresno. The first five miles will be over moderately level country, the other thirty through an open and practically level country under ideal conditions for transmission. It is estimated that the power which will be delivered in Fresno at present from the three phase generators will not be less than 900 H. P.

At the Fresno end the line will be brought into a sub-station and then the current will be transformed down. From the sub-station power will be delivered to all the mills in town, the water works, machine shops, planing mills, laundries, printing presses, elevators, packing houses, etc. It will also be used to drive the street railway system of the city which will require about 300 H. P. In the sub-station, two arc dynamos, each of 60 lamps capacity will be driven by an induction motor, the motor being mounted on the same bed plate as, and being direct connected to, the dynamo. Current will be supplied for 4400 incandescent lamps.

Gas and fuel in the San Joaquin Valley have always brought an extremely high price and this may be considered as the most potent reason for the present installation. It is believed that power can be supplied when the plant is started, at about half its present cost; and to the towns around Fresno the privileges of electricity will probably be extended as soon as possible. This plant may easily be considered as taking the lead in the use of a high head of water and the distance over which the power is transmitted.

MISCELLANEOUS.

TELEGRAPHIC CIPHER CODES.

The International Telegraph Bureau is a telegraphic clearing house and intelligence office located at Berne, Switzerland, of which all the Governments of Europe, and all the important nations of the rest of the civilized world, with the sole exception of the United States, are members. "Berne," as the bureau is generally referred to, is the central information bureau of the telegraph service of the whole world. Any interruption to a cable or land line, the opening of a new line, or rearrangement and shortening of an old one; all delays to telegraphic communication, anywhere and from any cause, such as storms or earthquakes, or censorship on telegrams because of war or civil disturbance in Cuba or Armenia, or anywhere else; anything and everything that improves or disturbs the telegraph service in any part of the world, is at once reported from the affected locality direct to Berne, and the information is promptly sent out from there to the head quarters of every Government and telegraph company, and so on to every telegraph office of importance in the world. While the United States is not represented at Berne, or in the international conventions, this country shares in the information, and is to a great extent under the domination of Berne. With a few exceptions all the cable lines in this hemisphere are owned by British companies, and in telegraphing to Cuba or South America even, Berne's territory is entered.

Berne is really the center of everything telegraphic, and "CQ," in the nomenclature of telegraphy, is the circumference of everything. Every city in the world has its code, recognized by Berne and known everywhere. Thus "LN" means London, "NY" New York, "BM," Bombay, "SZ" Suez, "CT" Calcutta, "MV" Monte Video, and so on. A message from Berne simply addressed "IQ" would quickly find its way to Iquique, away over in Chili. "CQ" means "all stations," and a telegram sent from Berne telling, perhaps, of an interruption of communication with Australia by reason of an earthquake in Java, addressed simply "C Q," would be passed from one government and telegraph company to another, and from centre to centre, until inside of twenty-four hours it would reach every office of importance in the world.

There has always been a difficulty between the telegraph service and its customers over the use of cipher words. Of course, where the cost of telegraphing runs to several dollars a word, every effort is made to be brief. Most elaborate and really wonderful codes have been constructed, some at a cost of thousands of dollars, by the aid of which one word is made to express a whole sentence, or paragraph, of commercial information. To such a science has this matter of codes been reduced that the bulk of telegrams passing between this country or England and distant places like China and Australia rarely consists of more than two or three words. Many hundreds contain only one word, besides the name and address. And one word often sums up a whole day's business. To insure accuracy and speed the convention decided many years ago that only legitimate words, belonging to one of eight languages, should be allowed in codes, and no word should contain more than ten letters. Arbitrary combinations of letters, such as xup, or wzy, are only accepted on a basis of three letters to a word. While cable operators are not expected to know eight languages, yet there is something about a legitimate word from a modern language that makes it easily recognizable. It sounds all right on the Morse instrument and looks all right on the cable slip. A mutilated word is as readily distinguished, and stopped. The sender of a foreign telegram of eight words may use a word each from English, German, French, Italian, Spanish, Portugese, Dutch and Latin, but they must be good words, and not over ten letters long. The receiving clerk in a cable office will almost infallibly spot an illegitimate word, and, as he is held responsible, at the rate of several dollars a word for any wrong word he may pass, he lets very few indeed get by him.

But so elaborate have codes become that pretty nearly all the good, available, and safe words, not too much alike to cause confusion or liability to error, have been used up, and for many reasons the legitimacy of words is often called in question. Perhaps the sender of the telegram wants to use a word like immediately, in its normal sense. But that word contains eleven letters, and maybe from ignorance of the rule, or, perhaps, because of the money involved, the sender drops out an "m," and attempts to get "imediately" over the wires. But it is not likely to go far, for cable operators are about the most careful and expert craftsmen in the world. One interesting incident of this sort came up in an English office some years ago in relation to the word "pando" which appeared in a telegram offered for transmission to Bombay. Pando is a legitimate Latin word, but the telegram was otherwise in English, and the text showed beyond any doubt that "pando" stood for "P. & O." meaning the Peninsular and Oriental line of steamships running to Bombay. The cable company claimed that it was an evasion, and the sender finding out later that the word happened to be good Latin, insisted on the right to use it and have it counted a single word. But Berne upheld the company.

Such difficulties are continually arising. Others come from the similarity of many code words, where the difference of a letter, or a telegraphic dot, might mean a difference of thousands of dollars in a quotation. To avoid all such difficulties in the future, the last convention held at Paris in 1890 instructed the bureau at Berne to prepare a vocabulary which should, after a specified date, constitute the sole authority as to the legitimacy of code words. A corps of experts was set to work on this vocabulary, and after five years of really great labor the vocabulary has been completed. It contains 250,000 words of not more than ten letters each. Every word has been tested and compared, by chirographic and telegraphic standards, and it is believed that under ordinary circumstances, no two words will become mixed or confused in any way. The amount of labor involved in this compilation will easily be appreciated when it is considered how much alike hundreds of words are. It is said that every word in the vocabulary differs in at least two letters from every other word in the 250,000.

The Berne vocabulary will not go into force until January 1,1898, in order to give opportunity to users of codes to make their ciphers conform to it. But after that date any word not contained in the Berne book will not be accepted for transmission in Europe.—*N. Y. Sun.*

THE DISTRIBUTION OF ANIMALS.

The apparent anomalies in the distribution of animals on the surface of the earth have for a long time attracted the attention of the zoologist. How came the lemurs, those frail inhabitants of the tropical forests, to live along the southern parts of Asia, separated from their kin in Africa and Madagascar by the wide ocean? Why should ostrichlike birds live in in Africa and Australia, and again at the southern part of South America? Not long ago, zoologists, relying upon the current opinion of geology, played the Titan with land and water, inventing great continents and planting them in the oceans. Thus, at their command, "Lemuria" arose from out the sea to make a land passage from Madagascar to India; even at the present moment many assert that a huge continent, now sunk in the waste of waters round the southern hemisphere, stretched from the cape to Australia, and from Australia to Patagonia.

But geology, as it has abandoned the theory of catastrophes for the theory of slow transformation, is also giving up belief in such gigantic alterations of land and sea. The great oceans, the great land masses, it tells us, date as far back as geological evidence goes. Oceans and continents may have altered their outlines; Malaysia, now an archipelago, was once a continent. Africa, now a continuous land mass, may have been broken up into islands by the intruding sea. In great land areas, continuous slow rising and falling has occurred, each area passing recurrently through successive phases; archipelagoes have risen to be indented continents, indented continents to be a continuous mass, and the whole has then slowly fallen back again to its original condition. But the sea and the land in their broad masses remain as when first divided.

What, then is the form of this sempiternal configuration? In the minds of most of us it is a vague image remembered from a distorted "Mercator's Projection," or from the Eastern and Western hemispheres flattened on the pages of an atlas. These images are dimmed toward the poles, and so fail to give the most striking aspect of sea and land. But, taking a globe, turn either pole alternately toward you. In the south a clump of icebound land, well within the Atlantic circle, surrounds the pole. All else is the wide domain of ocean, broken only by tapering and isolated tongues of land, South America, the Cape, Australia, leaning down from the north. On the other hand, all the great continents expand in the northern hemisphere and shoulder each other around the pole. America is separated from Asia only by the shallowest and narrowest of straits; an elevation of a few fathoms would unite Greenland with Europe. The great land area of the globe is as a cap thrown over the northern hemisphere, with only tattered fringes hanging across the equator to the south.

And where did terrestial animals come into being? Tradition places their home eastward in Eden. Science points certainly to some part of the great northern land area as the centre of life for the larger terrestial forms. We know that these arose successively, primitive birds like the ostriches coming before higher forms, like the pheasants and singing birds, the pouched marsupials preceding the antelopes and the lion, the lemurs coming before manlike apes. Each wave of life, spread over the whole continuous area, producing after its kind; then, pressing around the northern hemisphere it met a thousand different conditions of environments, different foods, enemies and climates, and broke up into different genera and species. But there was never a wave of life that had not another following it. In the struggle for existence between the older and newer type, generally the newer prevailed and drove the older southward toward the diverging fringes of the land masses. The vanquished left behind them on the field of battle only their bones to become fossils. Sometimes succeeding waves swept along to the extreme limits of the land, and many early types were utterly destroyed. But others found sanctuary in the ends of the south, and were preserved in islands broken off before the newer types had reached them, or saved their lives by becoming creatures of the night, dwelling in the fastnesses of tropical forests.

Fossil bones of ostrich-like birds occur in Europe and in Asia and in North America; their living representatives are the cassowaries of New Guinea, the emus of Australia, the ostriches of Africa, and the rheas of South America. The oldest mammals now alive, the duck-billed platypus and the spiny echidna, layers of eggs, kinsmen of the reptiles, have allies among American and European fossils; in life they are found only in Australia and New Guinea. The pouched marsupials once ranged all over the earth, covering it with a strange mimicry of existing mammals. Now they have been beaten out of Europe and Asia, even out of Africa, and almost entirely out of North America; but they have found refuge in South America, and, secluded in Australia, they form nearly the whole of primitive fauna. So also with the lemurs; their fossil remains bestrew the whole earth. A few surviving forms remain in the forests of Africa and southern Asia; still more of them, shut off in Madagascar, have defied the advent of newer arrivals.—*From the London Saturday Review.*

ONE RIVER'S THREE NAMES.

"Some queer kinks in nomenclature are discoverable in this country of ours," said Col. William Stapleton of Trinidad, Col. "Running right through the town of Trinidad, in which I live, is a little river, which familiarly and indiscriminately does its muddy, flowing business under three names. It is called variously the Las Animas, the Purgutorio, and the Picket Wire. The names came about in this way:

"Santa Fe, N. M., claims to be and is about the same age as St. Augustine, Fla. Both towns are considerably over 200 years old, although I forget the exact date of their settlement.

"Back in the middle of the sixteenth century the Spaniards at Santa Fe made up a military detachment to go overland to St. Augustine. The old Dons didn't know anything of the country which lay between. All they were posted on was the distance and the general direction, as they knew the latitude and longitude of both places. Rather late in the fall some 700 of them, steel-clad soldiers, camp followers, baggage train, and women pushed in through the Raton Pass over the trail now followed by the Santa Fe Railroad, and at the beginning of winter made a camp at what is now the site of Trinidad, which sits fairly in the mouth of the Raton Canon, looking out on the plains.

"There they were on the very threshold of the Rockies. To the east of them, over which their course must trend, lay an utter waste of plains, apparently without limit. All that winter the Spaniards camped in the mouth of Raton Canon. With wine, woman, and song they put in a hilarious time, and probably had as much fun as they ever had before or since. Winters are not rigorous and spring comes early in the vicinity of Trinidad.

"With the first coming of the early grass the adventurers burnished their armor, fitted up their horses, and got ready to move. The camp followers, the women, and the extra baggage they sent back to Santa Fe. When last seen the party bound for St. Augustine, numbering several hundred, were marching down they valley of the little river by which they had camped.

"That was the last ever heard of them. Not a feather ever floated back to tell the story of their fate. With the last flap of the banner, and the last sun-glint on the rearmost steel cap, they disappeared from the earth. To this day no one is able to make a suggestion even as to what became of them, except that it is supposed they were butchered by the Indians.

"Fifty years ago there was an old Comanche chief named Iron Shirt, because of a rusty old shirt of chain mail which he wore, but neither he nor any of the other Comanches knew anything of the origin of the garment nor where it came from. It had been in the tribe further back than the short Comanche memory could reach. Many have supposed that it was a relic of this Spanish expedition of three centuries ago, which had apparently marched off the earth that far-away spring day in the mouth of the Raton Canon.

"But now for the kink in the nomenclature I was thinking of. The disappearance of these Spanish soldiers seemed so eerie and witchlike that it made a profound impression on the superstitious people they had left behind. They named the little river Rio de Las Animas, meaning the River of the Lost Souls, and it is supposed to hold the story of the expedition's dark fate and repeat it to itself in the river language, which the Mexicans do not pretend to understand.

"When the French fur traders under Sublette and Saint Vrain came trapping in those waters from St. Louis, in a French effort at translation they made out that the 'River of the Lost Souls' must mean the Purgatory river, and so gave the river the translated name of Purgatorio.

"Later, when the American bullwhacker marched through on his way to Santa Fe, he accepted French name, but called it Picket Wire. To this day the river wears all three titles, as the reader would soon learn by turning to the Trinidad newspapers, where he would find cattle brands advertised as having their ranges variously on the Las Animas, the Purgatorio, and the Picket Wire.

"Every man picks out his name for himself, but they all mean the same river. It isn't much of a river, either, only about twenty feet wide at Trinidad. The Mexicans, however loyally stick to the name 'Rio de Las Animas,' and Mexican mothers tell their children of the soldiers who hundreds of years ago marched from there and were never heard of again."—*From the Washington Evening Star.*

KEEPING FRUIT FRESH.

A vast deal of fruit is wasted throughout this country because, as a rule, people are ignorant of the best ways of caring for or preserving it.

For example, no fruits should ever be put into ice closets or refrigerators. "What nonsense!" some will say, "why everybody does it." True, yet it is nevertheless a pernicious and wasteful custom.

Our grandmothers, splendid, economical housekeepers as they were, kept fruit fresher and longer than we do, with our ice chests and coolers. In cool, well-aired pantries or closets, or well-stoned dry cellars, luscious peaches, plums, pears, apples were kept for months undecayed and wholesome.

Some of the best housekeepers I know, after storing ripe or cooked fruits in ice closets year after year and finding them mildewed and spoiled, have changed the errors of their ways and returned to grandma's excellent, thrifty habit of keeping fruits in cool closets, or the store room in the cellar.

Why does fruit keep fresher and sounder in well-cared pantries than in ice chests? Because that is nature's way of of preserving it. Every ripe fruit that falls to the ground in nature's domain, drops to cool dews, is hidden in the tall, shielding grass or covered by fallen leaves. Try a ripe pear, that has lain on the ground all night, at half-past 6 in the morning. No ice-kept fruit begins to compare with its rich, juicy freshness. Then, too, when fruit kept for home in the moist, icy temperature of refrigerators is taken out chilled or half frozen, and suddenly exposed to the heat of kitchens or dining rooms in hot weather, decay sets in with terrible force and rapidity.

No doubt much of the poor digestion prevalent in summer is directly due to our national habit of eating fruit no longer fresh or wholesome, which has been kept all day or night in refrigerators.

How appetizing these remnants of yesterday's fruit look! withered, decaying, mildewing; served up by anxious, penny-saving housekeepers. You would save more fruit, besides the family health, by keeping such materials in pantries or closets. Or better still, stew strawberries, raspberries, currants, blackberries, left over after they have once been offered fresh to the family or guests. If nobody cares for them stewed, with sugar, of course, why just strain them and put the juice into clear jars or bottles.

My word for it, the family will clamor for more of the delicious, healthful, cooling drinks these fruits make added to water, and spend less for harmful compounds at soda water fountains.

Fruits are often served in poor condition, either too green or decaying.

Bananas, when green or unripe, should be kept a day or two in a warm, dark place. Then take them out and the mellow, rich flavor will repay the trouble.

They are very nourishing. Try salt with them if they seem indigestible; the salt brings out the flavor and assists digestion.

Dry your lemon and orange peels under the stove in tin pans or platters, and they will then kindle fires splendidly; there is so much oil in the rind.

Pineapples are more often eaten half-ripe than any other fruit, because so few have ever eaten them where they grow, and know not how delicious they are when fully ripe. To test them, try to pull out the stiff, green leaflets at the top of the fruit. If they come out easily the pine-apple is ripe; if not, keep it in a cool, dark place until it mellows. People in the tropics are extremely careful to remove every speck of the eyes on the rind, and never eat the round, hard core in the middle of the pine-apple. A delicious preserve can be made of pineapple stewed with sugar.—*M. E. Carrel in the Philadelphia Inquirer.*

IS MARS INHABITED?

There is one discovery that was made during the last year which seems opposed to the otherwise strongly supported hypothesis of a close resemblance between Mars and the earth. It relates to Mars's atmosphere. The great English spectroscopist Huggins, the famous Italian astronomer Secchi, and more recently the indefatigable German observer Vogel, have all put on record their belief, based upon studies of the spectrum of Mars, that that planet possesses an atmosphere resembling the earth's and containing the important element aqueous vapor. Vogel, indeed, went so far as to say, about ten years ago, that "it is definitely settled that Mars has an atmosphere whose composition does not differ appreciably from ours, and especially the Martian atmosphere must be rich in aqueous vapor."

More recent observation have appeared to confirm those of Vogel. But now comes Professor Campbell, of the Lick Observatory, employing some of the most powerful and perfect spectroscopic apparatus in existence, and shows that, so far as the spectroscope is able to inform us, there is no evidence whatever of the existence of a Martian atmosphere containing watery vapor, or even that Mars has any atmosphere at all! His observations, made in June, July, and August of 1894, show that the sunlight reflected to us from the surface of Mars undergoes no perceptible absorption such as would arise from the existence of an atmosphere surrounding the planet, and that the lines in Mars's spectrum which other observers had ascribed to the absorptive effects of its atmosphere are really due to absorption by the atmosphere of the earth.

Professor Campbell's observations do not entirely dispose of the supposed atmosphere of Mars. They simply indicate, as he has himself pointed out, a superior limit to the extent of such an atmosphere. He thinks that if Mars had an atmosphere one-fourth as extensive as the earth's, he would have detected its existence. Against the conclusion that Mars has no atmosphere and no aqueous vapor stands the unquestioned existence of the white polar caps of the planet, waxing and waning with the seasons. As to this, Professor Campbell says, "While I believe that the polar caps on Mars are conclusive evidence of an atmosphere and aqueous vapor, I do not consider that they exist in sufficient quantity to be detected by the spectroscope."

In other words, Mars does not possess an extensive atmosphere, but it may have one about one-quarter as extensive as ours. Does such a fact preclude the supposition that Mars is a habitable world? Hardly; for although we should die like fish thrown out of water if three-fourths of the atmosphere were suddenly withdrawn from the earth, yet it is plain that beings resembling ourselves and our contemporaries in the animal kingdom would require comparatively slight adaptations of structure to enable them to live in an atmosphere no more extensive than that which the spectroscope yet allows to the planet Mars.—*From Harper's Weekly.*

ALASKAN SNOW HOUSES.

Many adventurous prospectors have been making their way in the last year toward the Yukon River valley, in Alaska, and they have had to live very much after the fashion of the natives. Caribou and moose abound, though it is not much sport hunting them when the thermometer registers 50° below zero.

The natives construct snow huts in about the time that would be required to pitch a wall tent. They select a place where the snow is about four feet deep. A space 6 by 9 feet is marked out. Blocks two feet square are cut from the surface snow and set on edge around the excavation for side walls. At one end three feet of the space is dug down to the ground; in the balance about two feet of snow is left for a couch. The sides and ends are built up tight and the whole is roofed with broad slabs of crusted snow cut in proper dimensions to form a flat gable roof, and loose snow is thrown over all to chink in. At the end, which is dug down to the ground, a hole is cut just large enough to admit a man crawling in on his hands and knees. The hut is now finished and the sleeping bags and provisions are packed inside. The arms and ammunition are generally left outside. After the outside work is finished everybody crawls into the hut and the opening is stopped up from the inside with a plug of snow that has been fitted carefully, and no one is expected to go out until it is time to break camp. The combined heat from the bodies of the inmates, together with the lamp they use, soon raises the temperature, and a degree of comfort is obtained, no matter how cold it may be on the outside. The Alaska *Mining Record* says that a similar degree of warmth is obtained by no other manner of camping in that region. Snow tents that are occupied for a month or more are more elaborate, and are usually built when the snow is six or eight feet deep, as the roof can then be made higher and the hut entered by a covered way and through an ante room in which the dogs sleep and the sleds and other articles are stowed.

When fuel is obtainable a kichen is added to the structure with a fireplace cut out of the solid walls of snow. Fire in such a fireplace has been used for an hour a day for a month. The first heat softens the exposed snow, but the snow afterward changes into solid ice and remains unchanged so long as the temperature in the open air remains below zero. About the middle of April such snow houses are no longer available as they become too damp for comfort, and the usual practice is to dig a hole down into the ground and roof the abode with skins. In such houses some of the prospectors and travellers lived in comfort last winter.—*N. Y. Sun.*

RIGHT ON TIME.

The science of navigation has been reduced to such accuracy that the modern passenger steamer may be expected almost upon the hour. Take, for example, the "*Campania*." In 1893 she made eight trips, and her average voyage was 5 days, 20 hours and 18 minutes. In 1894 she made ten trips, and her average was 5 days, 20 hours and 17 minutes; only one minute less in 1894 than in 1893, in a voyage of 2,770 miles in all sorts of wind and weather. Nor is this exceptional. The "*Teutonic*" made twelve trips in 1893, on an average time of 6 days, 4 hours and 8 minutes. In 1894 she made eleven trips, and her average was just a trifle slower—6 days, 4 hours and 17 minutes. The "*Etruria*" is a little more irregular. Her average in 1893 was 6 days, 6 hours and 47 minutes. In 1894 it was 6 days, 7 hours and 28 minutes. The "*Havel*" made ten trips in 1893, with an average of 7 days, 7 hours and 38 minutes for a distance of 3,080 miles, from the Needles to Fire Island. In 1894 she made nine trips, with an average of 7 days, 7 hours and 21 minutes. The "*Furst Bismarck*" made nine trips in 1893. Her average for the year for a voyage of 3,080 miles was 7 days and 15 minutes. In 1894 she made six trips, and her average was 7 days and 54 minutes. The "*Columbia*" made nine trips in 1893, with an average time of 6 days, 22 hours and 12 minutes. In 1894 she made six trips, with an average of 6 days, 22 hours and 8 minutes. The "*New York*," though not the fastest, has the best record for regularity of any of the Atlantic fleet. Her average time has not varied for years, and she can be expected almost on the minute every voyage. She has crossed the Atlantic more times, and has carried more passengers than any other steamer of her age, and has been more regular about it. The "*New York*" made fourteen trips west bound, in 1893, with an average time of 6 days, 21 hours and 31 minutes. In 1894 she made fifteen trips, west bound, with an average of 6 days 21 hours and 45 minutes. Her sailing distance was 2,770 miles. In 1893 she made thirteen trips, east bound, with an average of 6 days, 20 hours and 39 minutes, which was just one minute faster than her west bound time that year. In 1894 she made fifteen trips, with an average time of 6 days, 20 hours and 24 minutes. Therefore, in crossing the ocean fifty-seven times in both directions, at all seasons of the year, her widest variation for two years was only 1 hour and 21 minutes. The old "*City of Chester*," also of the American line, is another steady boat, her average being 9 days, 15 hours and 11 minutes in 1893 and 9 days, 15 hours and 28 minutes in 1894.—*Scientific American.*

WHY WE COOK FOOD.

It would be absurd, in the face of the tempting viands daily placed before us, to say that food would be just as well uncooked. Yet to render food more palatable is the least of the reasons for cooking it. Man is endowed with teeth which are suitable for the mastication of both flesh and a vegetable diet; and it would need but a comparatively short time to accustom him to raw food of either description.

Unfortunately, or fortunately, as the case may be, all food has to undergo certain changes before it can be taken into the system as nourishment. Part of these changes take place in the mouth when the food is subdivided by the process of chewing or mastication, and part are made by the action of the juices of the stomach upon the mass.

Nourishment depends upon the completeness with which food is changed by the processes of mastication and digestion. In this modern era, when everything is done with a rush, there is great danger of throwing upon the stomach more work than it can do, by the hasty and inefficient manner in which we chew our food.

Here we perceive the great province of cooking—that of an intermediary agent between an insufficient mastication and an overtaxed stomach. In other words, cooking may be made to serve, to some degree, the purpose of mastication. Potatoes cooked till they are "mealy" need much less time and chewing than those which are boiled hard and "soggy."

On the same principle, the pride of the housewife is in her "light and spongy" bread. It is better than the hard cakes of milled corn and water that were relished in primeval days, because the minute bubbles of air which are incorporated into the bread facilitate its digestion, without the labor of long chewing which the cakes demanded.

Meats and vegetables, upon being properly cooked, lose the covering inside of which the fibres and grains of nutriment are hid, a result which, it is true, may be similarly obtained by mastication. We must not suppose, however, that it is easy to obtain proper results in cooking, or to recognize them when they have been obtained. Because an article of food is palatable and slips into the stomach without effort may be the last of reasons why it should be nutritious and easily taken care of by the stomach.

Indeed, so great are the difficulties in mastering the proper methods of cooking, and so important are such methods to the human economy, that the subject deserves to be treated rather as a science than as an art.—*Youth's Companion.*

AN EARTHQUAKE DETECTOR.

It has become possible to discover an earthquake and to mark its force at a distance of over 7000 miles. This seems to smack of magic, but it is, nevertheless, a scientific fact. Some time ago it was stated as simple truth that the earthquake in Algeria was made known to the scientists in Paris itself while it was actually taking place, by the undulations of certain delicate instruments over a strip of paper. That the movements of the earth could thus transmit themselves almost instantaneously, registering, as it were, across the Mediterranean and nearly the whole of France more quickly than a telegraph message could have been sent, was thought hardly plausible. But it can well be believed now, in view of a recent more marvelous demonstration of the self-registering of an earthquake much further away.

Within an hour from the time it commenced the late earthquake in Japan had revealed itself to the instruments of the Roman College. The oscillations of the earth outlined themselves on a single sheet of paper clearly and distinctly, showing plainly that there were five separate "disturbances" of varying force. Recent scientific reports that have just come from the Japanese Empire confirm the accuracy of the instruments of the Roman College in a most remarkable manner. The practical part of the discovery is that the approach of an earthquake may be told with little chance of error, though it must be confessed that the instruments give no hint of direction, nor do they indicate the starting point.

Instruments of this character were at Nicolaieff and Charkow, cities in the central part of Russia, and here the Japanese earthquake mentioned was registered even more plainly, the distance in this case from its seat being fully 4500 miles. The instruments in these towns were carefully watched at this time and they were seen to oscillate and mark the tremblings of the earth for over an hour.

One of the most remarkable of modern inventions, indeed, is this seismograph, which was invented by Bertelli, the "Father of Earthquakes." The most valuable evidence of its practical benefit to mankind was in 1883, when the sensitive machine gave warning of an eruption of Mount Etna. Up to this time, however, it has only been valuable for foretelling shocks comparatively near at hand. The long-distance instances recorded above are the first in the history of the seismograph.—*New York World.*

"BUILDING" A BOOK.

"ALTHOUGH we are apt to speak of the 'writing' or the 'making' of a book, rather than of its 'building,' each of these is a distinct operation; and when a book, first written, then made, is finally ready it has been built as truly as a house or a ship is built. It has demanded an equal amount of careful planning, skilled labor, and close attention to the thousand details that go to the making of a completed whole." With these words Kirk Munroe begins an exceedingly interesting and valuable article on "The Building of a Book" in *Harper's Round Table* for August 6th. Himself a successful author of tales of adventure, Mr. Munroe is enabled by his own experience to speak with confidence upon such topics as authorship, the training that fits one for the profession of letters, the selection of a subject for a projected work, the preparation of the manuscript, and so on to the moment when "the precious manuscript is put into a box and sent off to a publisher." At that point in the narration the fund of Mr. Munroe's varied experience is still farther drawn upon, and we find him examining the newly arrived manuscript from the publisher's point of view. For the purposes of this article of course the book is accepted, the questions of royalty and copyright and such matters are adjusted, and we are led onward through composing-room, press-room, and bindery, with entertaining descriptions of the mechanical processes that precede publication.

Naturally, the most quotable portions of the article are those relating to the creative period—as where Mr. Munroe says: "So every one, except those who know, imagines book-writing to be so easy that most of those who desire to earn a livelihood without very hard work try their hands at it. The girl of brains and education, thrown upon her own resources, decides to become an author; and, after a desperate struggle, fails because she has no real experiences to draw from. The sea-captain who is too old to follow his chosen profession, but must still make a living, and is brimful of experience and adventures, decides to become an author. When he, too, meets with failure, he blames everybody and everything except himself, and rarely discovers that the reason he cannot become a successful author at his time of life is because he has not been trained to the business, and does not know how to write."

THE TEMPERATURE UNDER US.

Beneath the peninsula of Lower Michigan there are brines and sheets of mineral water lying in basin form, and very rich in salts, bromides, etc., and of great medical and commercial value. They have been reached by numerous wells, which run down to about 3000 feet near the centre of the basin, as at Alma and Bay City. The water comes up from the bottom of these wells hot (over 90 degrees), showing a decidedly more rapid increase in temperature than in the copper mines. But the famous Comstock lode, where fabulous wealth lured the miners on, showed perhaps the most rapid increase in temperature that man has ever dared to face. It was, however, doubtless due to the action of hot water rising from still greater depths—probably the same waters that deposited the silver ores—still at work.

In the mines of this region the miners, naked as savages, reeking with perspiration, drinking pailful after pailful of ice water, (twenty tons of ice, or, in another case, ninety-five pounds per man, were used each day), could labor but ten minutes at the drift (in imminent danger of being scalded by striking a stream of hot water) before being overcome by the heat and reeling to a cooler place. Fainting, delirium, even death, have been the effect of the reaction on coming to the surface. Verily, the Cuban proverb that a Yankee would be found to go after a sack of coffee though it were at the gates of hell, was not far from the literal truth. However, the rate of increase of temperature may vary, all indications thus agree that less than ten miles below us a red heat is attained, and within twenty a white heat. Think of it! Ten miles below us it is red hot. Ten miles above us we have the pitiless cold, far below zero, of interplanetary space. To what a narrow zone of delicately balanced temperature is life confined!—*The Popular Science Monthly.*

SILK UNDERWEAR.

Some years ago, a child, feeble from its birth and the object of the tenderest solicitude on the part of its friends, was, on the advice of a specialist, put into all-wool garments. From underwear to cloak, everything was of pure wool. The plan had worked well for some children, but in this case the little one rapidly declined in health and spirits until its friends were alarmed. Finally an elderly visitor suggested clothing the child in silk. She said that after years of invalidism she had found pure silk garments a most agreeable and healthful change. She made this discovery by accident. Being taken with a heavy chill, there was nothing in the way of wraps available but an enormous old-fashioned shawl of white crepe and a silk patchwork quilt. Being wrapped in these, the sensation of warmth and electric glow came to her almost immediately. As she was subject to these attacks, it occurred to her that the silk might have something to do with the almost instant relief. Time after time she tried the experiment on herself and members of her family, with the most surprising results.

On her advice the little one was provided with silk garments. Her knitted underwear was changed only every other day, being worn constantly day and night. Petticoats, waists and dresses of soft silk were worn, and within ten days the improvement in the little one's condition was remarked by every one.

Several sick persons have been similarly treated with the happiest results. Of course, this may not answer for every one, but when there is a long continued stage of feebleness, when ordinary remedies seem ineffective, it is well worth while to resort to out-of-the-way means to bring about the desired change. There are persons whose temperaments seem to indicate a demand for unusual healing methods. And for these the rule of average is not only absolutely without sense, but sometimes injurious in the extreme.—*New York Ledger.*

HINTS ON FOOD.

It has been demonstrated over and over again that man cannot live on a diet composed of any one of the alimentary principles. Whenever the attempt has been made to support life on any one of them, such as albumen alone, or sugar or starch alone, or simple gelatine, the result has been a practical starvation. An experimenter managed to support life for ten days on a diet composed entirely of albumen, derived from bullock's blood and water. Symptoms of an alarming nature soon showed themselves, and at the end of ten days he was obliged to desist. Attempts of a less rigid kind also terminated in a similar way; and in those cases where life had been supported entirely upon lean meat or upon cheese the health has quickly deteriorated. In some conditions of the constitution, such as diabetes, it becomes necessary to deprive the patient of carbohydrates, because of his inability to assimilate them; and only those who have themselves suffered or have closely watched the sufferings of others can be aware of the misery which a restricted diet of this kind entails on the sufferer, and the terrible longing for the forbidden food. In the early days of his existence man is dependent entirely on one article of diet, viz., milk, and it is a remarkable and most instructive fact that milk contains an admixture of all the alimentary principles we have enumerated—the albuminates, carbohydrates, fat, water and salts. Milk may, therefore, be regarded as a typical food. If milk is allowed to stand, the cream rises to the top, and may be skimmed off. This is the fatty constituent of milk. If to the skimmed milk some rennet be added, the casein will coagulate and can be separated as curd. This is the albuminate or nitrogenous constituent of milk. The fluid left after the coagulation of the casein, which is known as whey, contains the sugar of milk, or lactin, which is the carbohydrate constituent, as well as the salts and most of the water. Roughly speaking, therefore, butter, is almost pure fat, cheese is almost purely albuminous, and whey is the vehicle of the sugar and salts.—*Cassell's Family Physician.*

THE END OF ALL THINGS.

"TAIL-PIECE" This title Hogarth, the celebrated English painter, gave to his last work. Grouped in an ingenious manner, he painted the following list to represent the end of all things; a broken bottle; the butt end of an old musket; an old broom worn to the stump; a bow unstrung; a crown tumbled to pieces; towers in ruins; a cracked bell; the sign-post of an inn, called the "World's End," falling down; the moon in her wane; a gibbet falling, the body gone, and the chains which held it dropping down; the map of the globe burning; Phœbus and his horses lying dead in the clouds; a vessel wrecked; Time with his hour glass and scythe broken; a tobacco-pipe with the last whiff of smoke going out; a play-book opened, with the *exeunt omnes* stamped in the corner; a statute of bankruptcy taken out against nature; and an empty purse.

Hogarth reviewed this work with a sad troubled countenance. Alas something lacks. Nothing is wanted but this, and taking up his palette, he broke it and the brushes, and then with his pencil sketched the remains. "Finis, 'tis done!" he cried. It is said that he never took up the palette again, and a month later died.—*Harper's Round Table.*

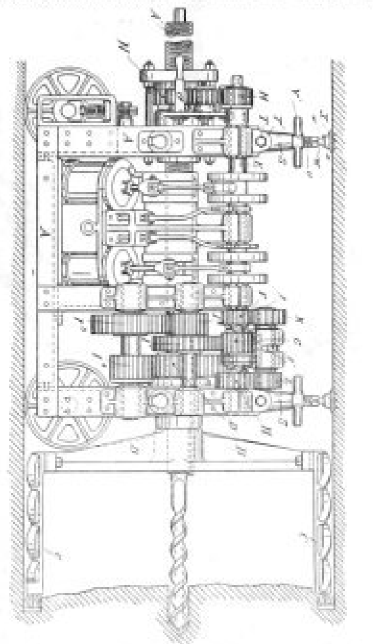
WHERE THE PRESIDENTS ARE BURIED.

George Washington is buried at Mount Vernon, Virginia; John Adams at Quincy, Massachusetts; Thomas Jefferson at Monticello, Virginia; James Madison at Montpelier, Virginia, James Monroe at Richmond, Virginia; John Quincy Adams at Quincy, Massachusetts; Andrew Jackson at Nashville, Tennessee; Martin Van Buren at Kinderhook, New York; William Henry Harrison at North Bend, Ohio; John Tyler at Richmond, Virginia; James K. Polk at Nashville, Tennessee; Zachary Taylor at Louisville, Kentucky; Millard Fillmore at Buffalo, New York; Franklin Pierce at Concord, New Hampshire; James Buchanan near Lancaster, Pennsylvania; Abraham Lincoln at Springfield, Illinois; Andrew Johnson at Greenville, Tennessee; Ulysses S. Grant at Riverside Park, New York; Rutherford B. Hayes at Columbus, Ohio; James A. Garfield at Cleveland, Ohio; Chester A. Arthur at Albany, New York.—August *Ladies' Home Journal*

NEW INVENTIONS

TUNNELING MACHINE.

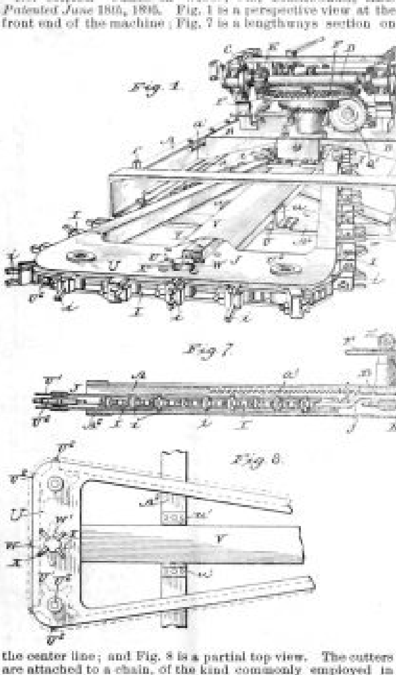
No. 540,396. THOMAS W. FRY, CHICAGO, ILL. *Patented June 4th, 1895.* This invention consists of improvements in the tunneling machine, which is known as the "Stanley Header," and which is described in THE COLLIERY ENGINEER for Dec. 1893. These improvements consist in the addition of gearing, whereby the speed of the revolving cutter head *B*, may be changed to suit the requirements of rock having hard streaks in it, etc. The engine pinion *F*, drives a train of reducing gears *K*, *L* and *H*. The pinion *G*, may be clutched to either *F* for high speed, or to *H* for slow speed.



The wheel *D*, drives the main spindle by means of a feather. The spindle is fed foward by means of a nut wheel *N*. This wheel is connected by a train of three spur gears to the engine pinion *M*, in such a manner that the motion may be reversed at any time, by the handle *O'*. Thus the driving wheel *G* may be thrown out of gear if desired, and the feed nut be turned, either way, at any speed. The jacks *S* are hinged as shown, so that they resist the twisting tendency of the machine, yet may be readily turned down, to facilitate moving forward or back.

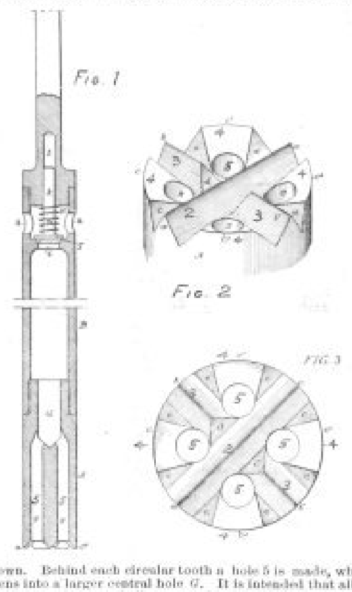
MINING MACHINE.

No. 541,184. JAMES A. WIGGS, JR., BIRMINGHAM, ALA. *Patented June 18th, 1895.* Fig. 1 is a perspective view at the front end of the machine; Fig. 7 is a lengthways section on the center line; and Fig. 8 is a partial top view. The cutters are attached to a chain, of the kind commonly employed in machines of this class, which runs around suitable sprocket wheels at the front corners of the cutting head *U*, and is driven by a sprocket *H* at the rear end of the frame. This sprocket is rotated by means of the gears *F* and *E*, and the engines *C*. The cutting frame is fed forward by means of pinions which engage the racks *a'*, which are secured to the stationary main frame *A*. The feed pinions are driven by means of a train of fast and loose gears which operate in either direction, according to the position given to the clutch lever 3. The cutting frame is guided by means of a central bar *V*, which moves between the clips *u*, on the front cross girt *A²*. It is also guided in the coal by means of a block *Y*, which enters into a narrow groove above the main kerf, which is cut by means of the small cutter head *X*. This head is rotated by means of a sprocket wheel between the upper and lower plates, which engages the main cutter chain.



ROCK DRILL.

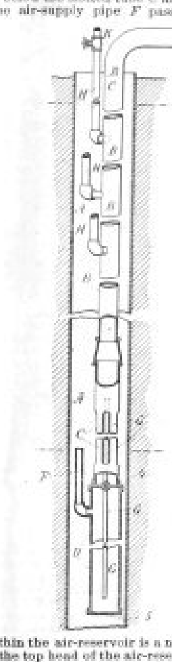
No. 542,542. THOMAS SYMONDS, LEOMINSTER, MASS. *Patented July 9th, 1892.* Fig. 1 is a lengthways section of the drill; Fig. 2 is a perspective view, on a larger scale; and Fig. 3 is an end view showing the plan of the cutting edges. The edge 2 extends across the face of the bit, and the edges 3 extend at right angles with 2, but do not intersect with it. The circular edges 4 are sloped backward and downward as shown. Behind each circular tooth a hole 5 is made, which opens into a larger central hole *G*. It is intended that all of the chips and water shall pass up through these holes while drilling. At the upper end of the drill tube *E*, is a valve *I*, which opens during the down stroke, and closes during the upstroke of the drill. Thus the drill acts like a pump to suck up the borings and water, and to drive them up through the bit and drill tube.



PNEUMATIC PUMP.

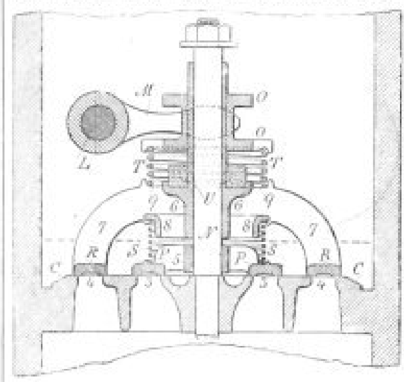
No 542, 622. JAMES E. BACON, RICHMOND, VA. *Patented July 16th 1895.* The well A may be of any desired character. The same is usually bored and provided with a lining-tube extending down to the rock, and the uptake or discharge pipe B is of a size adapted to the volume of liquid to be discharged, and the lower end of this uptake-pipe is slotted, as represented, and below the slotted tube *C* an air-reservoir *D* is provided. The air-supply pipe *F* passes down to the reservoir *D*. Within the air-reservoir is a nozzle or tube *G*, passing through the top head of the air-reservoir and rising above the inlet-openings in the pipe *C*. The pressure of the air in starting the well must be sufficient to drive the water out of the reservoir *D*, and then the air will discharge the water rapidly from the nozzle *G* and start the well suddenly by the upward movement given to the column of water in the uptake-pipe, and in so doing any sediment or foreign materials in the well will be rapidly carried out; and the pressure afterward necessary to continue the flow of water in the uptake-pipe will be but little in excess of the weight of the column in the well above the upper end of the nozzle *G*.

In some instances it is advantageous to supply air to the uptake-pipe at one or more places above the air-reservoir *D*, and with this object in view pipes *H* are provided with elbows screwed into the uptake-pipe *B* at several places, and these separate tubes extend to the top of the well and are provided with valves *K* to regulate the admission of air under pressure, so that its discharge into the uptake-pipe may aerate the water to the extent necessary to raise is to the required place of delivery.



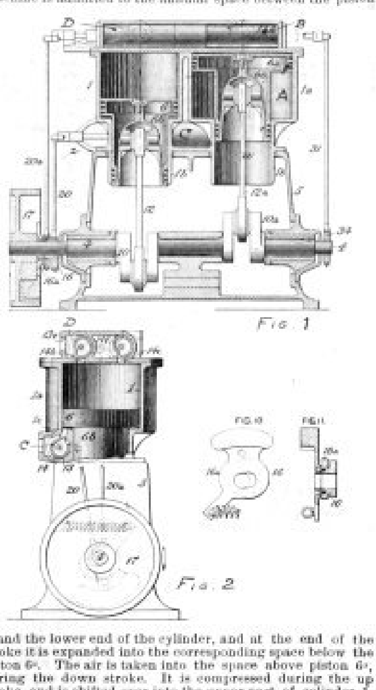
PUMP VALVE.

No. 542,083. GEORGE DE LAVAL, WARREN, MASS. *Patented July 2nd, 1895.* This improved valve is made in two parts *R* and *P*, which are really independent valves. Both are annular in form, and both slide up and down upon the stem *N*. The opening of the inner valve *P*, is resisted by the spring *S*, which bears against the ring 8 on the arms of the outer valve *R*. This spring is made light, so that *P* can open very easily. The outer valve is held down by a spring *T*, which bears against a moveable collar *O*. This collar is moved vertically by an arm *M*, which is connected to the piston rod or plunger, so that it moves in unison therewith. As the plunger begins its stroke, the arm *M* rises and takes the pressure nearly off the valves. The resistance of the valves to the passage of water is thus reduced. As the plunger nears the end of its stroke, the arm *M* descends and compresses the spring *T*, thus urging the large valve to its seat. The smaller valve *P* remains open until the stroke is finished, but being quite small, it takes its seat without perceptible shock or jar. Thus the advantages of a positively moving valve are attained, without positively arresting the current of water, allowing the momentum to be spent in useful work instead of useless shocks.



AIR COMPRESSOR.

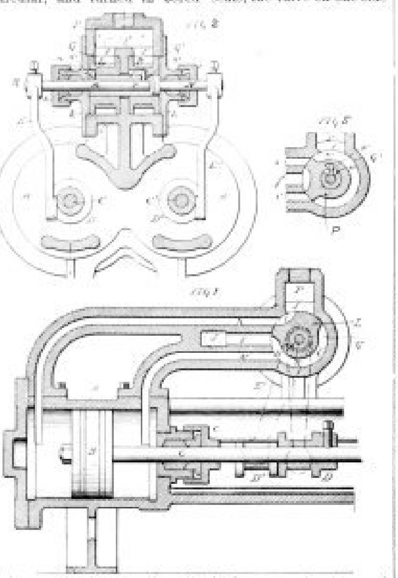
No. 542,426. FRANCIS M. RITES, PITTSBURGH, PENNA. *Patented July 9th, 1895.* Fig. 1 is a vertical section of a double compressor; Fig. 2 is a vertical cross-section; Figs. 10 and 11 show the construction of the governor eccentric. The cylinders are different in size, 1 being the high pressure, and *A* the low pressure cylinder. The steam to drive the machine is admitted to the annular space between the piston 6, and the lower end of the cylinder, and at the end of the stroke it is expanded into the corresponding space below the piston 6ᵃ. The air is taken into the space above piston 6ᵃ, during the down stroke. It is compressed during the up stroke, and is shifted over into the upper part of cylinder 1, where the compression is completed. Thus, the steam is used expansively, and the air is compressed in two opera-



tions. The inlet air valve *B* is moved positively by the eccentric 34 and rod 31. The air discharge valve *D* is moved by the eccentric 16², and rod 20², and the steam valve *C*, which controls both cylinders, is moved by the eccentric 16 and rod 20. As shown in Fig. 10, both eccentrics are made in one piece, but are on opposite sides of the shaft, so that when they are shifted by the governor 17, the throw of one will decrease exactly as that of the other increases, and vice versa. Thus, when the governor alters the point of cut-off of the steam, it simultaneously opens the discharge valve earlier, and so adjusts the work done in the compressor cylinder to the power exerted in the steam cylinder. Both compressor pistons are coupled by rods 12 and 12² to double cranks, which are exactly opposite to each other. By the construction shown, a very compact machine is secured, which is capable of operating at high speed.

DUPLEX PUMP.

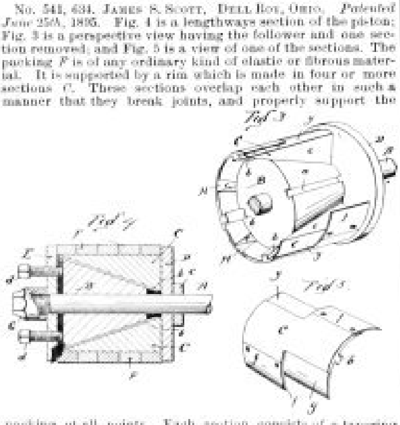
No. 540,898. John W. Booth, Philadelphia, Pa. *Patented June 11th, 1895.* Fig. 1 is a vertical section through one of the cylinders and its corresponding valve chest; Fig. 2 is a cross section through the valve chest; and Fig. 5 is a cross section of the valve on the opposite side of the pump. Both steam cylinders have ports which extend to the steam chest *F*, as shown. This steam chest would, of course, be located closer to the cylinders, in actual practice. Both valves are circular, and turned in bored seats, the valve on one side



being moved by a lever *E* or *E'* which engages the piston rod on the other side of the pump. The shaft *E* extends into the hollow body of the shaft *N*, and operates the valve *P*, by means of a pin *p*, which projects through a slot in the shaft *N*. The valve *L* is moved by the shaft *N* and lever *E'*. The steam valves *L* and *P* are so constructed, that they must move in opposite directions to admit steam to the corresponding ends of the cylinders, because the pistons are moving in opposite directions, at the moment that either valve is reversed. The valves are easily accessible, and the working parts are very few in number.

PUMP PISTON.

No. 541, 634. James S. Scott, Dell Roy, Ohio. *Patented June 25th, 1895.* Fig. 4 is a lengthways section of the piston; Fig. 3 is a perspective view having the follower and one section removed; and Fig. 5 is a view of one of the sections. The packing *F* is of any ordinary kind of elastic or fibrous material. It is supported by a rim which is made in four or more sections *C*. These sections overlap each other in such a manner that they break joints, and properly support the



packing at all points. Each section consists of a tapering block which fits upon the surface of the cone *B*, and has a tongue or rib which slides in a dovetailed groove *a* in the cone. The ends of the sections are gripped between the follower *E* and the head *D*, by means of the nut *G*. When it is desired to expand the packing, the nut is eased off a little, then the cone *B* is forced forward by the set screws *d*, and *G* is again tightened, thus securing all parts firmly in place.

METHOD OF SINKING SHAFTS.

No 542, 765. Friedrich Honigmann, Aix La Chapelle, Germany. *Patented July 16, 1895.* This method of sinking bore-holes and shafts in water-logged ground or quicksand differs mainly from the methods heretofore employed, in that the lining of the bore-holes with tubes, or of shafts with masonry, is not done during the boring, but only after the bore-holes and shafts have been carried down to the firm ground which it is desired to reach. To enable this to be done, a resistance is offered by artificial means to the inrush of the fluid soil, to prevent the caving in of the sides of the hole during the progress of the boring. For the purpose of this resistance the hole is filled with liquid having a head considerably exceeding the natural pressure of the water in the water-logged ground through which the hole passes, and the liquid is composed of a mixture of clay and water or similiar materials, which brings the specific gravity of the liquid up to 1.2. The object of using such a semi-liquid is to increase the pressure of the internal column of liquid against the sides of the bore-hole or shaft, and more especially to render the sides of the boring water-tight down to a certain depth by the penetration of the clayey materials, and thus to prevent the escape of water to waste, from the interior of the boring into the surrounding soil. *A*, Figs. 1 and 2, designates a guiding-tube or filling-tube; *B*, the filled-in water. *C*, Figs. 1, 2, and 3, designates the clay infiltered into the wall of the hole by the water. *D*, Fig. 2, designates the bottom piece below

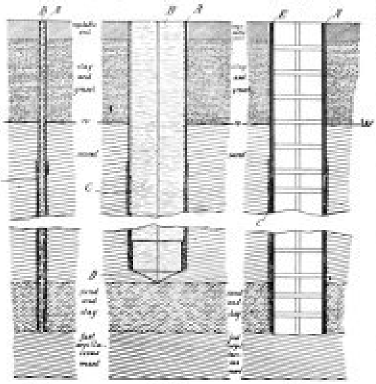
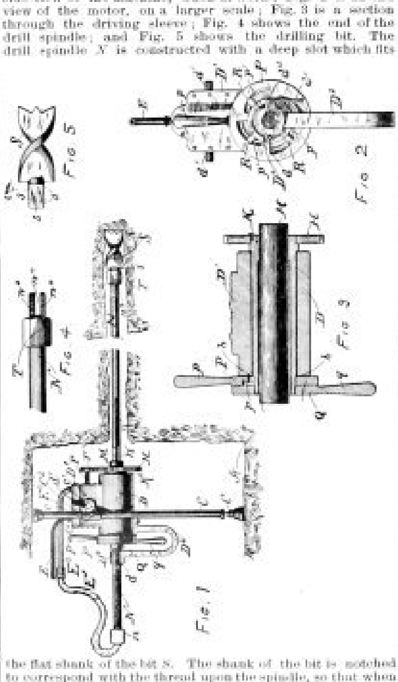


Fig. 1. Fig. 2. Fig. 3.

the tube *A*. *E*, Fig. 3, designates the complete lining. *w w* indicate the water-level. The operation is as follows: In the case of bore-holes of small size, such as are shown in Fig. 1, and in Fig. 2, the tube *A*, which may be called a "filling tube," is first sunk according to the method heretofore in use for a depth of from ten to twenty yards below the water-level for the purpose of keeping out the upper strata of loose ground and gravel, and of thus obtaining a firm guidance for the boring tools, &c., during the subsequent boring operation. When this work is completed, then the means above described are resorted to. For this purpose the tubing *A* of the hole, or the lining *A* of the shaft, is carried up as high as possible above the natural water-level *w w* and is filled with water. The specific gravity of the liquid is brought up to about 1.2 by mixing with clay or similiar material. While continually attending to these precautions, the sinking of the bore-hole or shaft is proceeded with by means of the usual boring apparatus, until the firm ground is reached, where the hole or shaft is to end. Then, but only after the boring has been completed, the lining-tubes or the shaft-lining *E* is inserted and carried down to the bottom of the hole, and thus the external soil is kept out.

COAL DRILL.

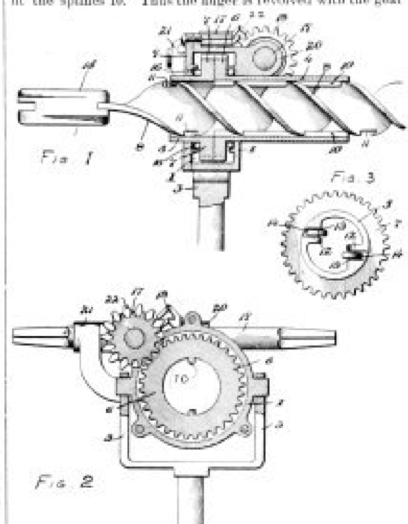
No. 542, 153. Robert H. Elliott and John B. Carrington, Birmingham, Ala. *Patented July 2, 1895.* Fig. 1 is a side view of the machine, when at work; Fig. 2 is an end view of the motor, on a larger scale; Fig. 3 is a section through the driving sleeve; Fig. 4 shows the end of the drill spindle; and Fig. 5 shows the drilling bit. The drill spindle *N* is constructed with a deep slot which fits



the flat shank of the bit *S*. The shank of the bit is notched to correspond with the thread upon the spindle, so that when the nut *T*, is screwed forward it secures the bit firmly in place. The spindle is tubular, and the exhaust air from the motor *D'*, is conducted by the hose *E'* to the rear end of it. The air passes through the spindle and escapes from holes near the bit, and serves to blow the chips and dirt out of the hole. The spindle is fed forward by means of the hinged half nut *D²*, which can be opened and released when desired. It is turned by the motor *D'*, gears *F'*, *H*, and the sleeve *M*. The spindle is turned by means of a feather in the sleeve *M* which engages the keyway shown. The connection between the sleeves *M* and *K* is frictional, and can be adjusted so as to slip, at any certain degree of resistance. The rear end of *K* carries several blocks *R*, see Fig. 2, which can be driven inward against the sleeve *M*, by means of the cam plate *P*. By turning *P* to the right, the blocks may be made to sieze *M* with sufficient force to drive the drill. If the bit encounters anything too hard to cut, *M* will slip and stand still, while the motor continues to turn. The cam plate is clamped in any position by means of the large circular nut *Q*.

COAL DRILL.

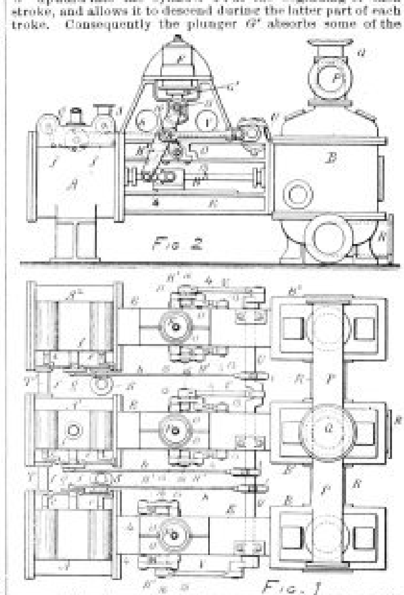
No. 539,491. John T. Snyder, Luzerne, Pa. *Patented May 21st, 1895.* Fig. 1 is a section along the axis of the machine; Fig. 2 is a cross section through the wheel 6; and Fig. 3 is a front end view of the wheel 7. In this machine the usual feed screw is discarded, and the spiral blade of the auger is used to secure a proper feed motion. The main driving gear 6 is constructed with a long tubular hub 4, having two splines 10, cast or otherwise secured to the inside of the bore. Each spiral of the auger is notched, as at 11, to fit the splines 10. Thus the auger is revolved with the gear



6, the central part of the bore remaining open. The feed motion is produced by the revolution of the gear 7, at a little slower speed than that of the wheel 6. This is accomplished by making the number of teeth in 7, one or two more than in 6. Both wheels are driven by the same pinion 17, and the bevel gears 22 and 18. The crank shaft 19 is fitted for a crank at each end. The feed wheel 7 is fitted with rollers 14 which engage the auger blades, and feed it forward with little friction. Both wheels run on ball bearings 16, so that the machine operates very easily. The working parts are mounted on trunnions, in a yoke 3, in the ordinary manner.

PUMPING ENGINE.

No. 542,084. George DeLaval, Warren, Mass. *Patented July 2nd, 1895.* Fig. 1 is a top plan of a triple pump; and Fig. 2 is a side view of the same. The piston rod of each pump is connected by a link 4, to a lever *H'*, which is attached at 15 to a plunger *G'*. The lever *H'* is suspended on a pin 16, upon a crank *O*. The crank together with the upper half of the lever, forms a toggle, which forces the plunger *G'* upward into the cylinder *F*, at the beginning of each stroke, and allows it to descend during the latter part of each troke. Consequently the plunger *G'* absorbs some of the



power of the steam, which is in excess at the beginning of the stroke, and gives it out again during the latter part, thus equalizing the driving force. The cylinder *F* may by supplied with pressure, or it may contain only a charge of air, which is alternately compressed and expanded. The form of connection shown ensures that the pump will always make full strokes. The steam valves are moved by eccentrics *i*, upon the shaft *U*, which is revolved by means of rods *V* connecting the levers *H'* to the cranks shown. No fly wheel is necessary.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 3. SCRANTON, PA., OCTOBER, 1895. WITH WHICH IS COMBINED THE MINING HERALD.

Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING FOR PLACER GOLD.

A NOVEL AND GIGANTIC SCHEME IN CLEAR CREEK CANYON, COLORADO.

Showing how Gold is Obtained on a Large Scale from Gold Bearing Gravels under Favorable Conditions.

(By Prof. Arthur Lakes, Golden, Colo.)

Having given an account in the September issue of THE COLLIERY ENGINEER AND METAL MINER of the general plan of the Roscoe placer scheme, describing the locality, the character of the undertaking and its aim, we will proceed to give a detailed account of the construction and of the progress of the work from its inception to the present. Two things had to be done at the outset; one was to build a big ditch or flume to carry off the water of the river and leave the river bed dry for a space of about half a mile or more; the other to get a sufficient head of water to work the nozzles and sand pumps at the places chosen for excavation.

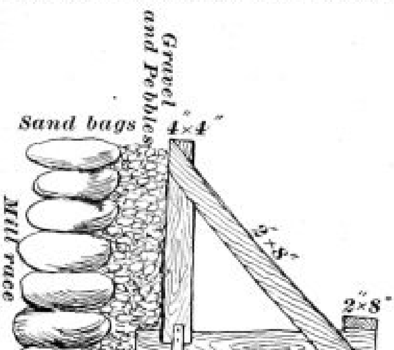


FIG. 1.—STRUCTURE OF EMBANKMENT.

Both works were begun simultaneously and whilst one party was making the flume to carry off the water another was laying pipes to bring on the water.

Beginning then with the great flume. By a natural widening of the bank on one side of the river the water was thrown to the other side and compressed into a comparatively narrow channel, thus affording a sort of natural flume to start with to aid in diverting the water from the coveted area of half a mile of river bottom. Starting with this natural advantage an artificial flume had to be built by sacks filled with sand placed along the natural flume so as temporarily to keep back the water till a more substantial triangular dam of timber partitions filled with stones could be built. Thus a "ground flume" was constructed as shown in figures 1 and 2. First a pile of bags filled with sand next the mill race, then a frame work of timber with triangular partitions set against it, and the intervals between the partitions filled with stones and pebbles faced or riprapped on the outer side with heavier stones, until the nature of the ground required and admitted of a flume of wholly sawn timber being constructed.

DESCRIPTION OF FLUME.

This flume that carries the river is 10 feet wide by 6½ feet high and 2,600 feet long. It averages about 22 000 gallons per second. The "bents" are made 4"x8" and are 16 feet long, with brace on outer side at an angle of 11½ degrees; the braces are made 2"x8" and are 5 feet long bolted to the 4" x 8" sill and upright post. Flooring 4" thick, boards 12" wide, length 16 feet. As the flume is not straight but curves, the curving on the floor is done by elevating the outside of the flume to the degree of curve like on a railway curve, which makes the water run level, the grade is 1½ inches in 16 feet. This grade is required by curving a flume and when the flume is straight the grade is ½ inch to 16 feet. The angle at which floor is cut for joining is not over 30 degrees, sides are made of boards 2" by 12" wide.

Next to get sufficient head and water power for the nozzles. To do this they had to go two miles up the river to a point where the descent of the stream was somewhat steep and rapid. There they built an intake flume of wood 6 feet wide and 4 feet deep and 800 feet long to a penstock or sand-box which is connected with an Allen wooden stave pipe 48 inches diameter. Before entering the penstock the water passes through a screen or iron grating or sand-box which catches the coarse rubbish floating in the water, and the overflow passes through gates on the south side. The main current passes into the penstock which is 8 x 8 ft. wide and 16 feet high. At the bottom is a well which collects any debris so the water passes clean and clear through the penstock into the 48 inch Allen pipe.

FIG. 2.—MAKING EMBANKMENT OF FLUME.

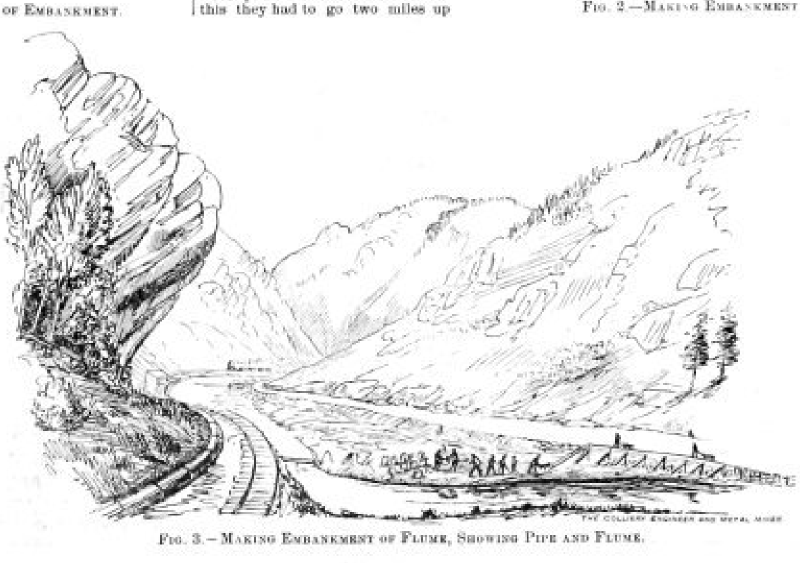


FIG. 3.—MAKING EMBANKMENT OF FLUME, SHOWING PIPE AND FLUME.

DESCRIPTION OF THE ALLEN STAVE PIPE.

This pipe is a modern invention by Mr. C. P. Allen, Chief Engineer of the Citizens Water Company in Denver. It originated in the problem of having to bring water in large volume a distance of many miles to Denver, in pipes which demanded unusually large diameter, and which if constructed of the ordinary metal, or earthenware material would have entailed very great expense. Mr. Allen, therefore, had recourse to the cheapest material on hand, viz: wood, and the now celebrated Allen stave pipe was evolved, which has stood both the effects of time and pressure. The pipe is made of staves of pine, banded with steel hoops. The staves may be from 2 to 8 inches wide and of any length, from 12 to 24 feet, the thickness from 1 to 2½ inches according to diameter and pressure. The flat sides are dressed to true circular lines and the edges are made radial to those circles, a certain number forming a circular ring composing the shell of the pipe. The staves are cut off squarely at the ends and have a saw-kerf cut across the face of each end, ¾" inch deep, for inserting a metallic tongue 1½ inches wide 2½ inches longer than the width of the stave.

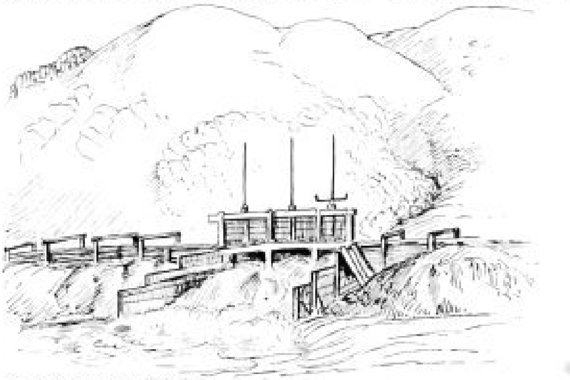


Fig. 4.—Floodgate Sluice on the Flume.

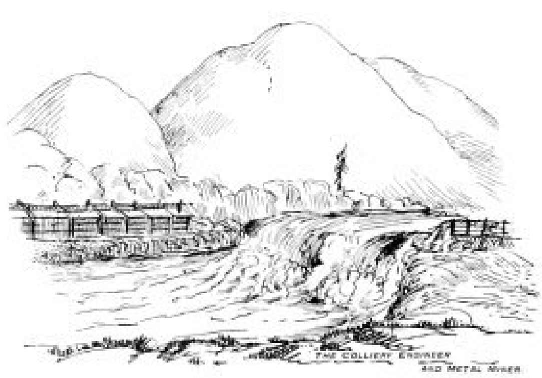


Fig. 5.—A Bad Break in Flume After a Freshet.

This slot is so made that the tongue will fit into it closely by tapping with a hammer. In construction all staves must break joints and although all the joints of one section are brought within a space of 2½ to 3 feet (over which 2 to 4 extra bands are distributed) no two adjoining joints are placed nearer each other than 6 inches. This insures great strength of joint and the overlapping of the metallic tongue into the staves on each side make a perfect butt joint.

The bands are of round steel with a head at one end and a thread 3 to 5 inches long at the other, the two coming together in a malleable iron shoe of peculiar make, fitted to the form of the pipe, and so arranged as to enable the staves to be drawn tightly together. When these bands are spaced for high pressure, the power of th numerous nuts turned up at moderate tension is sufficient to crush the wood and collapse it if carelessly exerted. The effect of this construction when the bands are at proper tension is to produce a stiff, hollow beam of wood of enormous strength.

The pipe is constructed in the trench where it is to lie which is made wide enough at the bottom to give standing room for the pipe layers on either side.

Two U shaped outside forms are first placed in the bottom of the trench 10 to 12 feet apart, and the bottom staves with the tongues placed in the ends, are placed loosely in position to form the bottom half of the pipe, inside which is then placed a ring of proper size.

The remaining staves are added, the bands are put in position, plac d the proper distance apart, and the nuts are tightened up part way. The staves are then coopered out to complete the true circle. When the pipe is round and true, and all the staves drawn up tight, earth is tamped all around the pipe and it is covered over and the trench refilled. Where the pressure is heavy the bands are but two to three inches apart. Gangs of men on a long pipe are placed every 1,500 feet, and

Fig. 7.—Connecting Wood and Iron Pipe.

when working in opposite directions and the gangs meet, coupling of the ends is effected by cutting the staves about ¼ inch longer than the space they are to occupy, and springing them into position, the bands closing all tightly together make the butt joints at the coupling very tight. Soon after the pipe is laid, water is slowly admitted, and the pipe allowed to soak, before the full pressure is applied which stops all minor leaks. The bands are made of mild steel bearing a strain of 70,000 lbs. per square inch. At one end they have a square head of special form, at the other a thread is cut 5 inches long for which distance the rod is upset. These bands are shipped in bundles as straight rods and bent on the ground around wooden tables. They are painted with asphaltum or red oxide.

The shoes are made of malleable iron. The tongues which are used in the butt joints are of strap-iron.

The Allen stave pipe is in use now all over the West for long water work systems, for irrigation and for mining purposes, with much success.

Figs. 7 and 8 show the method of connecting the wood and metal pipe as at Roscoe.

At Roscoe after leaving the penstock, (See Fig. 9) the pipe is buried for a distance of about 100 yards under a stone embankment and passes by a stone arch under the railroad.

Fig. 6.—Penstock and Intake Ditch on Flume.

It emerges from the ground on the other side of the railroad track, and follows the grade of the road the rest of the way close to the track, to its junction with the metal pipe. As this pipe has to withstand great pressure, it is somewhat closely banded, the bands being not more than 1 foot apart, and at places where a joining of the staves took place, extra bands are placed, and still closer togther. Still farther along the pipe with diminishing diameter, the pressure being increased, more bands are placed, and still closer together, sometimes not over 4 inches apart. The pipe is made to grow smaller and smaller in diameter, and is diminished and united on the principle of a telescope, and by this compression greater force and pressure is obtained. The pipe begins at the penstock with a diameter of 48 inches for a distance of 300 feet, then 42" for 400, 38" for 600, 30" for 800, 32" for 600, down by gradation to 22 inches diameter when it connects with the steel pipe, which also in course of its length tapers down to 16 inches. This steel pipe is ½ of a mile long. Another pipe after a certain distance connects with this, forming a double pipe for ½ of a mile, each pipe 12 inches diameter. One of these is for hydraulic giant nozzle purposes for blowing the gravel out of the banks and river bottom, the other to supply the sand pump for forcing or elevating the gravel some 45 feet or more from the bottom of the excavation up into the gravel and goldsluices.

Laying down the Allen pipe took 4 weeks and employed 34 men and cost at the rate of $1 50 per foot. The capacity or pressure of these pipes given at the giant nozzle is 87 lbs. per square inch and will throw a column of water 165 feet high from nozzle 4 inches diameter. With a closed pipe it would give a pressure of 189 lbs.

(TO BE CONTINUED.)

ACETYLENE GAS.

Its Properties and Its Commercial Value.

An exhibition and test of acetylene gas was given in the Board of Trade room in Scranton, Pa., on the evening of September 5th, by the following gentlemen, who represent the "Acetylene Light, Heat and Power Company" of Philadelphia, Pa.: Joseph A. Vincent, Edward C. Naphey, C. C. Adams, F. N. Lewis and Samuel L. Kent.

Through the kindness of the Board of Trade, the exhibition rooms were thrown open to those of the public who are interested in the new artificial light.

After the gentlemen from Philadelphia were introduced to the audience by Mr. D. M. Atherton, the Secretary of the Board of Trade, Mr. Vincent proceeded to explain the properties of acetylene gas, and calcium carbide from which it is obtained, substantially as follows:

"It is a well-known fact that carbon will combine directly with various metals under the influence of heat, and the resulting compounds are called carbides. The carbides of the alkali and alkaline earths, such as potassium, sodium, barium, strontium, and calcium whose oxide is known as lime, have the property of decomposing water upon being brought in contact with it, and thereby forming hydrate oxides of the metal and acetylene gas. Of all these carbides, carbide of calcium is the most interesting because of the low cost of the raw material (lime and coal) and of the commercial value of the residuum or by product (hydrate of lime) which is formed by the subsequent decomposition of the carbide of calcium upon contact with water. The chemical formula for acetylene gas is C_2H_2, which indicates that it is a satura ed hydro-carbon, containing in 100 parts, 92 3 parts of carbon to 7.7 of hydrogen. That such a gas as acetylene existed has long been well-known to the scientific world, but it remained for accidental discovery to learn that its preparation for commercial uses was a possibility. In 1888 Mr. T. L.

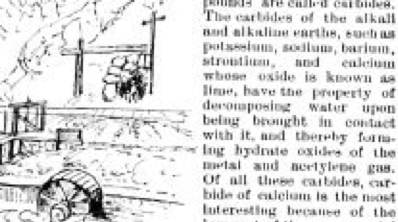


Fig. 8.—Showing Connection With Cast-Iron 24 to 20-Inch Reducer.

Wilson began a series of experiments relating to the reduction of the refactory metallic oxides by carbon under the intense heat of an electrical furnace, and found that lime, baryta, etc, when subjected to this heat were liquefied and formed molten masses which could be brought to ebullition.

An addition of carbon caused decomposition of the oxides, carbon monoxide being formed and driven off while the fused metal instantly with the excess of carbon formed a carbide. Further experiments showed that when a mixture of powdered lime and coke dust was introduced to the furnace, a syrupy mass of pure carbide of calcium was formed, also that this carbide became upon cooling, a dense, crystalline dark brown substance with a metallic fracture of blue or brown, and having a specific gravity of 2.62, and chemical composition represented by the formula $Ca\ C_2$ viz., 62.5 calcium, 37.5 carbon, which evolves a peculiar garlicy odor when exposed to a damp atmosphere, but is odorless in dry. When lumps of it were long exposed to the air the surface absorbed sufficient moisture to become changed to hydrate of lime, a thin layer of which protected the interior from subsequent decomposition.

"Carbide of calcium is now being manufactured at Spray, N. C., at a cost of about $30.00 per ton. Experiments have demonstrated that 87½ lbs. of lime and 56¼ lbs. of carbon will produce 100 lbs. of carbide of calcium, and 43¾ lbs. of carbon monoxide; and 100 lbs. of carbide of calcium with 56¼ lbs of water will produce 115.62 lbs. of slacked lime, and 40.62 lbs. of acetylene. The carbon monoxide is equal to 18¾ lbs. of carbon and 25 lbs. of oxygen. The above formulae will give some understanding as to the chemical reaction.

"Carbide of calcium is not inflammable, and can be exposed to a temperature of a blast furnace without melting, but when placed in water or its vapors, each pound of it will generate over 5½ cubic feet, (5.892) of acetylene gas, having a temperature of 64° F. It may also be decomposed by exposure to snow at a temperature of —24° F. The gas is colorless but makes its presence known by a strong garlicy odor. It is soluble in water equal to the volume of the latter, and can readily be condensed to a liquid form at much less pressure than is required for carbonic acid gas ($C\ O_2$).

"Acetylene gas at 67.27° F. requires a pressure of 39.76 atmospheres to solidify it. Carbonic acid gas, requires a pressure of of 58.84 atmospheres to solidify it, and as this represents the difference between 600 lbs. and 900 lbs. to the square inch, it may readily be seen that it has an important bearing upon the question of safety in handling and use. The carbonic acid gas tubes require a sustaining pressure 50% greater than is necessary for acetylene.

and 1,000 cu. ft. 4.000 candle power; as $1.00 produces in acetylene gas, 25,000 candle power, it would be necessary to sell city gas at 16c. per 1,000 cu. ft. in order to compete with acetylene gas on this basis.

"As there is less gas used, the oxygen of the air is not required to so large an extent in its combustion, and it is demonstrated that the air of a room lighted by this gas is vitiated at the rate of only ⅓ that of ordinary gas. The brilliancy of the acetylene flame would suggest the highest incandescence, but from actual test, it is much cooler than that of an ordinary gas flame. The temperature of an ordinary gas flame is about 1,400° C, but no part of an acetylene flame is higher than 900° C. In fact there is very little difference between the heat of an incandescent electric light and acetylene based upon the same illuminating power. It is apparent from this that in rooms where acetylene gas is used, there will be less danger of over-heating, and the products of combustion will not be so noxious as in rooms lighted with city gas. Another very important point in acetylene, as compared with the ordinary illuminating gas is, that the amount of carbon dioxide and water vapor produced is very small. A 5 foot burner of ordinary gas produces an amount of carbon dioxide that would equal the exhalations of about 18 adults, while the acetylene would equal the exhalations of about 3 adults.

"To sum up, acetylene gas is easily detected by its odor. It gives more light, throws out less heat, consumes less oxygen and can be produced at much less cost. It is capable of being stored as a solid, in the shape of carbide, as a liquid or as a gas. It may be shipped long distances as carbide or as gas manufactured from it, and as a liquid may be applied to all purposes of isolated lighting, especially as in railroads, street-cars, carriages, bicycles, steam-ships or sailing-vessels, street lighting and individual houses, or it may be used to enrich the gas in the city houses, stores or manufactories, its application for the latter purpose permitting the manufacture of a gas sufficiently low priced to be used for heating or fuel purposes.

"With all these facts in view it requires no gift of prophecy to foretell the early substitution of acetylene or all other forms of illuminating gas as well as electric lighting, and while it will work a revolution in the methods of lighting, it is bound from its very simplicity, safety, effectiveness and low cost, to work as well, a great revolution in all manufacturing processes. The city or town which can supply its street lamp from the tank concealed in its post, will not be slow in doing away with costly mains and connections. The small manufacturer will soon learn the utility of cleaner and cheaper gas fuel. The suburban resident may discard his dangerous oil or gasoline apparatus, and the city householder may laugh at gas corporations' exactions when he divorces his house from the meter and stores his six months' gas supply in his cellar closet."

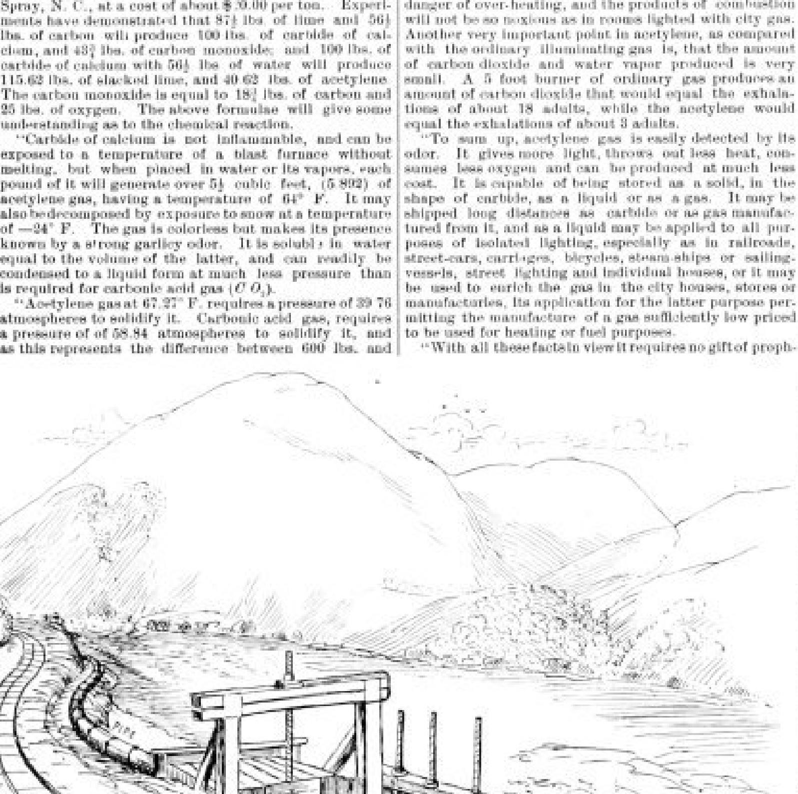


FIG. 9.—PENSTOCK WITH ALLEN'S STAVE PIPE ATTACHED, AT ROSCOE PLACER.

"Acetylene gas when subjected to sufficient pressure becomes a colorless mobile liquid and as the pressure is slightly relieved it commences to boil and evolve a gas, which upon ignition, burns with an intensely white flame, but if suddenly liberated would instantly solidify and form into a snow having a temperature of —118° F. and at this low temperature it possesses the same illuminating power as at the higher temperatures. The liquid gas is manufactured commercially by decomposing the carbide with water in a closed vessel, conducting the gas under pressure to a condenser, where it is liquefied and then drawn into tanks for distribution.

"One pound of the liquid when evaporated at 64° F. will produce 14½ cu. ft. of gas at atmospheric pressure, or a volume 400 times larger than that of the liquid. In ordinary service conditions the gas is not affected by the temperature, as it can be cooled to 100° F. below zero, or heated to 600° F. above, without impairing its illuminating power.

As an illuminant acetylene possesses lighting power and economy superior to any other illuminant known. When burned at the rate of but 5 cu. ft. per hour, its light is equivalent to 250 candles, and as good common gas is rated at about 20 candle power, it will produce 12½ times more light for the same quantity of gas. It has therefore 12½ times the value of illuminating gas.

"Assuming $20.00 as a cost to manufacture one ton of carbide of calcium which will produce 10,000 cu. ft. of acetylene gas, with a candle power of 50 candles per cubic foot, this would place the cost of the gas at $2.00 per 1,000 cu. ft. of 50,000 candles; $1.00 would therefore produce 25,000 candles. With good coal gas at $1.00 per 1,000 cu. ft., we get about 20 candles for each 5 cu. ft. burned, therefore, 1 cu. ft. produces 4 candle power,

A Successful Boiler.

H. E. Collins & Co., Bank of Commerce Building, Pittsburg, Pa., Sole Sales Agents for the Cahall Vertical Water Tube Boiler, manufactured by the Aultman & Taylor Machinery Co., of Mansfield, Ohio, report the following recent sales of Cahall boilers for the use of blast furnace gas: Illinois Steel Co., Joliet, Ill., 500 h. p.; Douglas Furnace Co., Sharpsville, Pa., 250 h. p.; Shoenberger Steel Co., Pittsburg, Pa., fifth order, 500 h. p.; Salem Iron Co., Leetonia, Ohio, third order, 500 h. p.; Sharon Iron Co., Sharon, O., second order, 500 h. p. Those for the utilization of waste heat from heating furnaces, are: St. Louis Stamping Co., Granite City, Ill.; second order, 150 h. p.; National Tube Works Co., McKeesport, Pa., 200 h. p.; Mahoning Valley Iron Co., Youngstown, O., second order 600 h. p. In addition they have secured the following recent orders for the direct fire type of Cahall Boiler: Wm. Tod & Co., Youngstown, O., 250 h. p.; Armstrong Cork Co., Pittsburg, 250 h. p. Messrs Collins & Co., have just issued a card containing a list of repeated orders received for Cahall boilers, the length of which shows the great favor with which these boiler are received.

MINING IN BRITISH COLUMBIA.

The Mineral Wealth of the Province and Its Rapid Development.

In a letter to the London *Times* of Aug. 23, Mr. Clive Phillips-Wooley calls attention to the great mineral wealth of British Columbia, and to the fact that Yankee enterprise is fast making that province "American in men, manners, money and sentiment." Mr. Phillips-Wooley as a loyal Englishman, deplores this, but he forgets that Yankee enterprise and bustle will do more for British Columbia in ten years than British conservatism will do in twenty, and, therefore, American influences in the province are the best.

While the silver deposits of British Columbia have proved themselves rich enough to pay "with silver even lower than at present," silver is not the only precious metal found. During the past year a gold-bearing belt of ore has been discovered and opened up, which added to the gold-bearing gravels of the province, seems likely to give British Columbia a prominent place among the gold producing areas of the world.

The completion of the Canadian Pacific Railway to Vancouver in 1886, made the province accesible to the world, but it is by no means sufficiently opened up by railroads, roads and trails to-day. Up till 1890 everyone in the province was too busy with town lot speculation to do anything towards developing the country. Since 1890 American capital and energy have proven the intrinsic value of the mines.

In speaking of the progress of development since 1890, Mr. Phillips-Wooley says:

"In 1890 there were no railways into West Kootenay. To-day there are three competing for her ores. In 1893 there were no shipping mines in the country. During the past 12 months, in spite of the silver panic and such difficulties of transportation as still exist, our silver-lead mines alone have shipped 26,500 tons of ore. An idea of the value of this ore may be obtained from considering a return now lying before me. A shipment of 2 114 tons sent from seven different mines to the Omaha and Grant Smelter, netted to the owners $107 per ton. This shipment is not selected for its exceptional value, but at hazard, as the first absolutely reliable statement of fact which comes to my hand.

"Last year a smelter, representing an investment of $750,000, was opened at Pilot Bay (close to Nelson), and not only is this to be enlarged, but within the last fortnight representatives of four of the greatest American smelting companies have been hovering about the district, their apparent aim being to make arrangements for the establishment of a great custom smelter at or near Nelson.

"What has been written so far concerns our West Kootenay galena fields and the one great bornite deposit at Nelson only, but since the autumn of 1894 another belt of mineral of an entirely different character to the mineral of Slocan has been opened up.

"We know that from the Kettle river to the Salmon river (a tributary of the Pend d'Oreille), at least, there is a belt of pyrrhotite, with some chalcopyrite, carrying gold in very considerable quantities, some silver, and a percentage of copper. In September, 1894, there were only four houses at Rossland, the principal camp, so far, on this belt. To-day, Rossland is a town of from 1,400 to 2,000 people, growing with truly American rapidity, from which last month four of her young mines shipped to Helena and Tacoma 2,330 ¾ tons, of the value of $115,386. New machinery is on its way into Rossland, and this monthly output will shortly be doubled. One mine alone is under contract to the Montana Ore Purchasing Company to supply 75,000 tons during the next four years, and another the War Eagle, has since its purchase in December last paid dividends amounting to between $84,000 and $90,000, thereby covering its original cost and all subsequent expenses. For this mine I am credibly informed that $940,000 is now offered and half a million for an adjoining property. Unless readers bear in mind the time in which these things have been done, the limited population we have to draw upon, and the abnormal scarcity of cash in this country, these developments may not seem great, and yet there must be some great intrinsic value in our mineral belts. If it were not so, our mountains would not be alive with prospectors from the Coeur d'Alene, our camps with middlemen representing the greatest American mining capitalists and ore-handlers, neither should we have in such a young country so many shipping mines. In the new belt we have already the War Eagle, Le Roi, Josie, Nickel Plate, Cliff, and Northern Star, whilst scores of prospects are being rapidly developed.

"In the silver-lead district the mines which have shipped are too numerous to mention, but the chief are the Slocan Star, Noble Five, Idaho, Dardanelles, Reco, Ruth, Blue Bell, and Alpha. Of these the Slocan Star bids fair, in the opinion of the most trustworthy authority whose opinion I have heard, to rival the famous Broken Hill Mine.

"Near Nelson there is one great bornite mine which should have long ere this made our country known on the London Stock Exchange. At last it seems as if it was to be worked in something like earnest. An aerial tramway is being put in to deliver 100 tons per diem, and within the next 12 months London ought to know as much of the Silver King as Nelson knows.

"Scattered throughout the country are free milling properties, one at McKinney, on which they have sunk 150 ft., another (the Poorman) near Nelson, which has paid for itself over and over again, and others at Fairview and elsewhere. Throughout the country companies like the Parrot Mining and Smelting Company, of Butte, Montana, and mining men like A. W. M'Cune, of Salt Lake City, Utah, are buying greedily, but every day fresh strikes are being made, prospects can be bought or bonded for a mere song, and camps like Boundary Falls, with huge deposits of comparatively low-grade ore, are neglected, because they are still 85 miles from a railway.

"It would be unfair to the province to conclude this letter without some mention of our gold gravels especially as local and eastern Canadian capital is being largely employed in their development. The story of Cariboo's gold returns to the poor men who worked with pan and shovel in the sixties has been told too often to need repetition. Since 1859 British Columbia has contributed $ 0,000,000 to the world's store of gold, of which by far the greater part came from Cariboo. This total does not include gold taken out by Chinamen, of which it seems difficult, if not impossible, to obtain an accurate estimate. To-day machinery can be taken into the gravels of the Fraser, the Semilkameen, and the Tulameen, and over a million dollars has already been expended in hydraulic work on these three rivers, whilst it seems likely that another field will be opened up this winter on China Creek, in Vancouver Island.

"The two great mines so far are the Cariboo and the Horsefly. Of these the Cariboo has just cleaned up $14,000 after a run of 127 hours, and the result of the first clean up of the Horsefly is daily expected, while the Anglo-American on the Semilkameen should be heard from early next month. The clean up of another small property on which $20,000 has been expended has just come to hand. The Nelson Hydraulicing Company has cleaned up between $4,000 and 5,000 in 120 hours' run.

"In considering the results it is only fair to remember that none of the mines are yet in fair working order, or at any rate not in such a state as to make a thoroughly representative showing of what they can do when fully under way. The Cariboo mines I have not personally visited, but upon the Semilkameen the results of panning in all sorts of places, likely and unlikely, from the river-bed to the grass roots, and in shafts 40 ft. deep, was an average of 25c. to the cubic yard. A large amount of platinum is also found in the gravels of the Semilkameen and Tulameen, which has been sold hitherto in the local stores at $4 an ounce."

In conclusion Mr. Phillips-Wooley says:

"It is worth while adding that the mining fields spoken of are so situated as to enjoy the advantages of water communication afforded by the Arrow Lakes, Kootenay river and lake, and the Columbia river, have all the lumber they require, and deposits of coal near the Crow's Nest Pass and elsewhere (near Boundary and in the Semilkameen) which can be tapped by railways at a very small expense."

Writen for THE COLLIERY ENGINEER AND METAL MINER.

MINE SURVEYING.*

LATEST AMERICAN IDEAS AND MOST APPROVED PRACTICE.

Rewritten for the use of Mine Officials, Surveyors and Engineers, from Lectures Delivered Before the Students of Columbia School of Mines.

(By Edward B. Durham, E. M.)

CHAPTER VI. (CONCLUDED.)

In the Hoosac Tunnel,† work was begun at both ends and at an intermediate shaft. At the shaft, two instruments were firmly bolted to foundations on each side of the shaft. They had a slit in a movable frame whose position could be determined by a series of observations, noting its position each time by means of an attached vernier scale. The mean of the different positions was taken and the slits were set in this position. Then two fine steel wires were stretched across the shaft between the sides of the slits, and between these were lowered the plumb wires, 25 feet apart. The wires were enclosed in boxes to protect them from falling water and air currents. At the bottom, a platform was built a few feet above the floor on which horizontal scales were placed behind the wires, and by them the centers of the swings were determined, and from these the center line was prolonged in both directions. The shaft was 1028 feet deep and the tunnel excavated for 1563 feet to the east and 2056 feet to the west of the shaft. The tunnel was carried in 11274 feet from the east portal, and 10138 feet from the west before meeting the headings from the shaft. The errors in alignment at meeting were 0.045 foot on the west and only 0.025 foot on the east side of the shaft. The error in grade is given as 1¾ and 1½ inches by someone, and by another writer as nearly 3 inches. Taking either figure for the grade as correct the results show very careful and creditable work on the part of the engineers. The total length of the tunnel was 25,031 feet.

On the Comstock Lode,‡ shafts were satisfactorily plumbed to depths as great as 3,000 feet, by hanging a plumb line in each of two compartments, so as to get them as far apart as possible. This gave a 9 foot base. At the surface a plank 12 x 2 inches was placed across the shaft and the wires let down by the edge of this and twisted around a nail in the floor. At the bottom a platform of two planks was placed across the shaft a little above each tub. One plank of each pair was used as a walk, and the other was placed about an inch from the wire. To this was nailed a small piece of white board so as to be only ¼ inch from the wire. Then a light was placed in line with the two wires, so as to throw the shadow of one of them on the board. As the wire swung to and fro the extreme positions of the shadows on the board, were marked with a pencil. The mean of any pair gave the central position and a number of observations were made to check the work. If in doubt as to whether the wires swung freely, at a given signal, the man at the top moved them an agreed distance, and they noticed whether they moved a like distance at the bottom, which they would only do if they were free.

On the new Crofton Aqueduct§ the shafts were placed with the longer dimensions parallel to the axis of the tunnel, so as to give the engineers as long a base as possible, and to one side of the centre, so as to leave a passage way at the foot of the shaft, through which the construction cars could pass around it. The shafts overlapped the centre line a few inches so the engineers could place their plumbing wires exactly on the centre line, and the two corners on this line were reserved for them. The large shafts were 17½ feet long and the small ones were 11 feet. The shafts were kept plumb in sinking by lines in the four corners, and on reaching the grade of the tunnel, the line was given for 50 to 100 feet on each side of the shaft by stretching a line along the center line as given by two plumb wires down the shaft, and marking it by points in the roof. When work had progressed a little further a more accurate line was given with the transit, set up in line with the wires, and finally when the work had advanced far enough, so that the points would not be disturbed by blasting, the permanent line was carefully determined.

The wires were set, at surface, on the center line by a transit placed 40 to 50 feet from them, and over a monument located on the line of the tunnel. The further wire from the instrument was adjusted first and then the near one. The wire was No. 8 piano wire, annealed, and wound on a six inch reel with a braker fastened to the head frame and from there the wire was led to a clamp with a tangent screw motion from which they hung down the shaft, and by which they were brought into line. The clamps were fastened to posts set in the ground, to prevent vibration from the machinery in hoisting. The wire was lowered by one pound bobs, which were exchanged at the bottom for 25 pound ones. The wires were examined to see that they hung clear, by a man who climbed down the shaft. After adjusting the bobs to clear the floor, they were hung in buckets of linseed oil, which were then covered loosely.

To get a steady sight at the bottom, an illuminated slit, Fig. 17, was devised to replace the wires. It consisted of two vertical strips of brass about 3 inches high, each attached to a horizontal bar moving in guides, and provided with separate tangent screws, so the vertical slit between them could be varied in position and in width. These were secured to a plank bracket close behind each wire, so that the further one appeared above the near one when a light was placed behind each. The slits were adjusted until slightly wider than the wires, and then, when they were exactly behind them the light would appear evenly on each side of the wire. This could be estimated very closely by

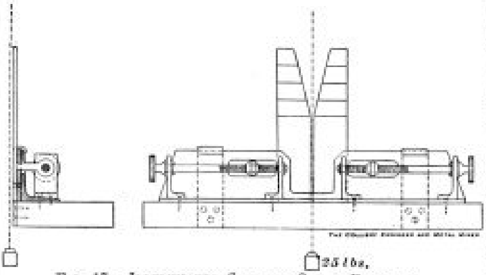


FIG. 17.—ILLUMINATED SLIT FOR SHAFT PLUMBING.

the eye placed in line with the wires. The plummets were then removed and the slits used to sight at. These remained fixed and could be easily bisected, and the center line transferred to the roof and afterwards prolonged to the headings. The first points were placed about 150 feet on each side of the shaft, giving a base 300 feet long. For these first points, holes were drilled in the roof, and plugs inserted, into which iron spikes were driven, Fig. 18. To each spike was bolted a brass plate with the zero mark cut in the lower edge, and below this was a vernier plate to whose zero was attached the plumb bob, and which was made to slide so as to bring the bob into line. The position of the vernier was then noted, and the plumbing repeated until they got three good determinations of the line, that agreed closely. Then the sliding verniers were set on the mean of the observations, and the line prolonged to the headings, putting in permanent marks in the roof at intervals.

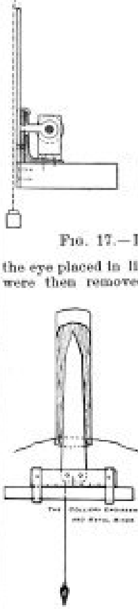


FIG. 18. TEST SPIKE AND VERNIER SCALE.

As the roof was over 15 feet high, the engineers used a tripod ladder Fig. 19, to reach their points. These might be useful for mine work. The cross-sections were

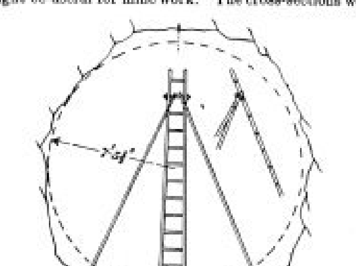


FIG. 19.—TRIPOD LADDER.

taken by a special instrument of their own design, for the description of which the reader is referred to the original articles.

Mr. Brough, in his "Treatise on Mine Surveying," gives the following method of determining the alignment of the underground survey, where it is not convenient or possible to set up the transit in line with the wires, Fig. 20. The two plumb wires A and B, are hung in the shaft as far apart as possible and located in the usual manner on surface. Then the transit is set in the mine at a point C, on one side of the line through the wires, and the distances A-B, A-C and C-B are measured with the greatest care. The three sides of the triangle are thus known, and the angles can be calculated by the formula,

$$\text{Sin.}\ \tfrac{1}{2}\ A = \sqrt{\frac{(\frac{1}{2}\,s-m)\times(\frac{1}{2}\,s-n)}{m\times n}},$$

in which A is any angle of the triangle, m and n are the sides adjacent to that angle, and s is the sum of the three sides.

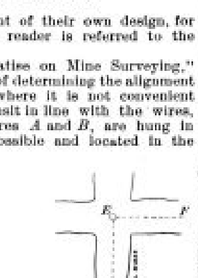


FIG. 20.—METHOD OF SHAFT PLUMBING SUGGESTED BY MR. BROUGH.

The angle at C can be measured with the transit, as a check on the calculations, and the angle between A C and the next course C E of the mine survey should also be measured. From the data thus collected we know the direction of A-B and the location of A as determined on surface, the angles $B\ A\ C$ by calculation, the angle $A\ C\ E$ by measurement and the distance A-C, hence the direction of the line C-E, and the location of C is known, and from these the relation of the whole mine survey to the surface can be determined. The position of C, with regard to the base A-B, makes a good deal of difference in the error in the angle at A due to small errors in the measurements of the sides. The worst cases are where the angle at A is large, as in the case of isosceles triangles with the base on A-B, and where the angle at A is very small, and A-C is the base of an isosceles triangle. The best case is where the point C is on a perpendicular to A-B from B and quite close to it.

Even under the best conditions a slight error in measurement would cause too large a one in the results to depend on the method for accurate work.

The "COLLIERY ENGINEER" strongly recommends a similar method to above, but more accurate, as superior to setting the transit in line with the wires. Four wires, x x x x, are hung in the corners of the shaft, Fig. 21-A, and are located on surface by radiating sights from four stations, which are arranged, one on each side of the shaft, so that the lines, joining opposite stations, run north and south, and, east and west, respectively. These lines serve as base lines from which the angle can be read by repetition from each of the stations to each of the wires. The distances from each station to each of the wires, and the six distances between wires are also measured. Then from the angles and distances, the co-ordinates of each of the wires can be calculated

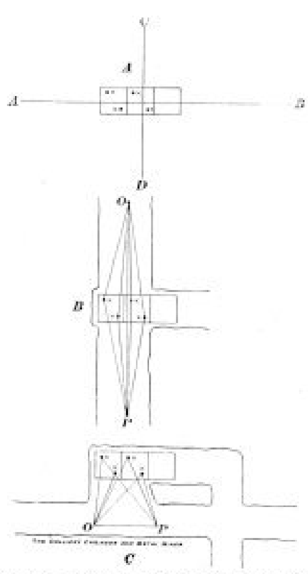


FIG. 21.—SHAFT PLUMBING WITH FOUR WIRES.

for the position determined from each station, and the results tabulated. Any observation which causes much variation in the position of a wire can be thus detected and repeated. The mean of the four locations is taken as the final position of each wire. The bearings of the lines joining each wire to each of the others are then computed.

There may be two positions of the shaft with respect to the gangway, Fig 20-B and C,—either the shaft is in it or to one side, both cases are lettered alike, so description will apply to either. Stations, O and P, are chosen as far apart as possible, so as to give the longest available base line. From both stations, radiating sights are taken to all four of the wires, reading the angles by repetition from the line O-P as a base, and measuring the distances as carefully as possible. The distances between each of the wires should have been previously measured, to see that they agreed with the surface measurements. Each station will then be at the apex of six triangles, each having the line between two wires for its base. Then the angle between the sides of these triangles, and their base can be calculated, and, knowing the direction of the base joining the wires from the surface survey, the direction of each of the sides can be determined. From these and the distances, there will be twelve locations of each of the stations, if all the sides of the triangles are used, since the co-ordinates of each wire are known. These locations can be tabulated, examined, and the means taken as the positions of the two stations. The direction of the line joining the stations can be calculated from the co-ordinates, and will thus form the base for the underground work. The distance down the shaft will give the elevations.

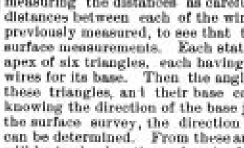


FIG. 22. PLUMBING BY TWO SHAFTS.

Speed and accuracy are claimed for this method, and the base can be determined, without regard to the position of the shaft with relation to the gangway.

Two Shafts.—Where there are two shafts entering a mine, a plumb-bob can be hung in each, and the alignment of the underground survey can be obtained much

* Begun in March, 1895.

† "Laying out Tunnels—Shaft Plumbing." Vose's Manual of R. R. Engineering. 1874 ed. p. 68.

‡ "Carrying a Survey Line down Shafts," by L. F. J. Wrinkle Eng. & Min. Jour Vol LV p. 81. Jan. 28, 1893.

§ "Tunnel Surveying on Division 6 of New Croton Aqueduct," F. W. Watkins, Trans Am. Soc. of Civil Eng. Vol. XXIII, 1890, p. 17-28 ill. Also "Sanitary Eng." Vol. XVI, p. 39, June 11, 1887.

more easily than with only one shaft and at the same time, more accurately. In Fig 22, *A* and *B* are wires hanging down their respective shafts.

The location of the two wires must be determined on surface by a traverse, and the direction of the line connecting the wires must be calculated.

Proceeding underground the two wires, *A* and *B*, are connected by a traverse, *A* — 1......9 — *B*. Then in the office, the underground survey is calculated, and the latitude and departure of *B* is found, with relation to *A*, using the course A — 1 as the assumed meridian with an azimuth of zero.

Course	Angle	Assumed		Hor. Dist.	Latitude		Departure	
		Azimuth	Bearing		N	S	E	W
A-1	0°00'	0°00'	North	17.6	17.6	......	0	0
1-2	177°33'	357°33'	N 2°27' W	42.4	42.3	......	......	1.8
2-3	284°07'	102°31'	S 77°31' E	131.0	......	28.1	128.9	......
3-4	177°56'	100°26'	S 79°34' E	167.5	......	30.3	164.7	......
4-5	181°54'	101°18'	S 78°42' E	93.0	......	18.2	91.1	......
5-6	158°33'	79°51'	N 79°51' E	82.8	14.5	......	81.5	......
6-7	184°53'	84°44'	N 84°44' E	37.4	3.4	......	37.2	......
7-8	184°26'	89°10'	N 89°10' E	61.2	0.9	......	61.1	......
8-9	94°53'	3°03'	N 3°03' E	61.2	61.1	......	3.2	......
9-*B*	135°11'	318°14'	N 41°46' W	11.8	8.8	......	......	7.8
					148.6	76.6	567.7	9.6
					76.6		9.6	
					72.0		558.1	

In this case the wire *B*, is 72.0 feet "north," and 558.1 feet "east" of *A*. The bearing of *A* — *B* will, therefore, be in the northeast quadrant and equal to the angle *CAB*, but $Tan.\ CAB = \frac{558.1}{72}$, hence CAB = 82°—38'. The azimuth of a line in the northeast quadrant will be the same as the bearing, hence the azimuth of *A* — *B* = 82° 38', on the assumption that the azimuth of *A* — 1 = zero. From the surface survey, the true azimuth of *A* — *B* was found to be 118° 36', hence the assumed azimuth is 35° 58' too small. The true azimuth of courses of the underground survey, can be found by adding 35° 58' to their azimuths, based on the assumed meridian *A* — 1. The true locations of *A* and *B* are known, and so the underground survey is fully connected with the surface.

The surveys connecting *A* and *B*, both on surface and in the mine, must be carefully checked, and the same precautions taken with the plumbing as with one shaft. If there are more than two shafts, the meridian can be determined by two and checked by the others.

At Przibram* in Bohemia, it became necessary to deepen the Franz Josef shaft, then down 1,380 feet, to the depth of the Adalbert and Maria shafts, which were 3,280 feet deep in order to facilitate the extraction of the mineral. In order to hasten the operation, it was decided to work from five different levels, by rising and sinking. To determine the position of the new portion of the shaft at each of these levels, they first placed plumb lines in each of the three shafts, and ran a traverse on the lowest level, which was open to all of them, to determine the triangle formed by them. Then by connecting the plumb wires in the two deep shafts, the surveys on each of the five levels could be oriented, and a cross cut driven to the site of the new shaft, and work begun. The shaft was driven full size, and lined up as it progressed. The holing through was so exact in every case, that no change was needed in the masonary lining. Each time a shaft was broken through from one level to the next, the survey was checked and the corrected triangle formed by the shafts, used for the next determination. The work required 11 miles of traverse with 684 set-ups.

One Shaft and One Slope.—Here the engineer would have a choice of several ways of determining his alignment. A plumb line could be dropped down the shaft, and from there with an assumed meridian the line could be run through the workings and out the slope, connecting it with the surface line, and then calculating the alignment backwards. Or, a line could be run in through the slope, measuring the horizontal angles only, to the foot of the shaft, then from there commence the surveys. The location of the plumb line in the shaft would be known from surface, and the line through the slope will give the alignment. Where the slope is flat so that an eccentric telescope will not be needed, a regular traverse can be run in through the slope, most easily, and then checked on the plumb-line in the shaft.

MEASURING THE DEPTH OF SHAFTS.

The methods, already described, of connecting the mine and surface surveys through shafts, give only the horizontal position of the underground survey referred to the origin, it is therefore necessary to determine the elevations of the workings, by measuring the depth of the shaft.

If the depth is measured directly with a tape, its weight and the pull upon it will tend to stretch it. In shallow shafts this can be made to equal its normal tension, but in deep shafts the weight of the tape, and the necessary pull to keep it taut, may exceed the normal. In such cases the upper end of the tape may be passed over a roller at the top of the shaft, and carried horizontally before winding on the reel. In this horizontal stretch, may be placed two points at an exact distance apart, then with the tape under tension as it is being used to measure the depth of the shaft, the distance between the fixed points is measured, this will then give the ratio of the measured to the true distance. Or the same ratio may be obtained by measuring with a tape at its normal tension, the distance between two graduations on the tape under the excessive strain. The horizontal piece of the tape thus compared with the standard, should be at least 100 feet long, so as not to multiply errors of observation to too great an extent.

Another method of determining the depth of a shaft is by using a steel wire (piano wire) with a weight attached to it, and measuring the wire as it is let down the shaft, and again as it is drawn up. This can be done by running the wire from the reel horizontally across a gauge, 50 or 100 feet long, then over a pulley and down the shaft. When the bottom of the weight is just even with the top of the shaft, a pencil mark or clip, is put on the wire opposite the end of the gauge nearest the reel, and then the weight is lowered until the mark is opposite the other end, thus one gauge-length of wire has been lowered, and another mark can be placed at the first end and another length lowered. This can be continued until the weight reaches the bottom, when the number of lengths let out multiplied by the length of the gauge, will be the depth of the shaft. If there is a fraction of a length lowered at the end, its length can be measured at the surface, as it will be the distance between the mark and the first end of the gauge.

Instead of a wire, the hoisting rope may be used in the same way.

The depth may also be measured directly by applying rods, chains or tapes to the guides, provided they are straight. For this purpose a seat is fastened to the hoisting rope, at the proper distance above the cage, on this an assistant sits, and holds one end of the tape, while the engineer rides on the roof of the cage, and holds the lower end. They can then apply the tape directly to the guides. A third man on the cage gives the signals for raising or lowering. A shaft 1095 feet deep was measured in this way three times in six hours, locating eight levels entering the shaft, and the distances agreed within $\frac{1}{10}$ inch. Another shaft 1,152 feet deep was measured four times and the greatest difference in any two distances was a little less than $\frac{3}{4}$ inch.

[THE END.]

* "Shaft Surveying at Przibram" Proceedings of Inst. of Civil Eng. London. Abstracts. Vol. CIV.

Written for THE COLLIERY ENGINEER AND METAL MINER.

THE ORE DEPOSITS OF CRIPPLE CREEK.

The Geology, Character, and Extent of This Famous Colorado Mining Region.

By Francis T. Freeland, B. S., C. S. S., A. I. M. E., A. S. M. E., General Manager Isabella C. M. Co., Cripple Creek; Durant Mg. Co., Aspen; Aspen Contact M. Co., Leadville, Colo., etc.

The northern part of the Cripple Creek district,—Tenderfoot, Gold, Globe, Iron Clad and Bull hills consist of andesite and andesitic breccia, bounded on the east, north and west by granite and gneiss. A tongue of granite runs into this region from the northeast just west of Bull hill and covers part of the headwaters of Squaw gulch. Mineral hill and Rhyolite mountain are masses of andesite surrounded by granite. Many of the hills are capped by phonolite flows. Dykes of phonolite are common and infrequent exhibitions of other eruptives may be noticed among which, basalt and diorite have been provisionally determined.

The ore occurs in fissure veins, as impregnated dykes, as an alteration of the edge of dykes, as chimneys at the intersection of a fissure vein and a dyke, and in the joints and cleavages of the country rock near the main fissure.

The valuable metals contained in the ores are gold and silver. Probably about $\frac{1}{4}$ of an ounce of silver is mined for each ounce of gold. Some of the gold is free, but with moderate depths the tellurides appear. The country rock shows some pyrite but the veins contain little and that low grade.

While some of the ore gives surprisingly rich returns, the product of the camp will probably average 3 ounces. This is to be considered a very high average grade for a gold camp giving this tonnage.

The principal associated mineral is quartz, both crystallized and massive. Some of the dull brown quartz is very rich. The opaque white and blue black quartz is poor. In the deeper workings a grey blue quartz will often show sylvanite on examination. Fluorite is also associated with the ores, and when dark purple or transparent it is considered a sign of value. The gouge in the fissure veins is usually a brown clay but sometimes white and rarely black. The gold in the clay and decomposed ores is fairly free. The quartz may be "frozen" to both walls, but in other parts the vein will have a "casing" of decomposing country rock, carrying small values.

The impregnated dykes are usually softer than the country rock, and the boundaries of the pay ore often indefinite. The ore occurring as a selvage to a dyke in andesite is generally an altered part of the dyke and shows a quite uniform greyish yellow color and contains more silica than the country rock. This selvage is locally called "jasper," as in the Moose mine. Such segregations and impregnations are apparently in chimneys associated with a crossing fissure vein. Yet often the fissure and the dyke too will be barren at some distance from the intersection. The Anna Lee shaft is on such a chimney. It is 760 feet deep and the deepest shaft in the camp at present. The Specimen and Bogart may also be put in this class. The dykes may be traced for considerable distances and shows much irregularity in thickness.

The principal fissure veins in many cases cut through the dykes and are but little affected by them. One vein has been seen to fault another, in the Zenobia. Most of the fissures run northwest or roughly parallel to the front range and main drainage system. While the veins maintain a general direction they vary greatly in strike and dip in their different portions. In some mines a particular course will correspond to a particular dip and bear some relation to the size and value of the ore bodies. See L. Moissenet. Observations on the Rich Parts of the Lodes of Cornwall. Trans. by J. H. Collins, London, 1877. The Isabella-Victor vein has been opened up for a length of a mile almost continuously and to a depth of five levels at the main shafts, and plainly shows this peculiarity. The Zenobia and Pharmacist veins have also been traced to some distance the latter to a depth of 520 feet. In Cripple Creek the veins seem in some instances to be in groups forming a plexus of veins with a large body of ore at their intersection. The Summit and Deerhorn mines are of the class. The Portland in the southern district is also a remarkable example. Other peculiarities of fissure veins such as splits, feeders, robbers, splices, horses and throws may be noticed.

The dykes and fissure veins also occur in the granite. In this case the ore is usually an impregnation of the granite for some feet from the fissure, the mica being replaced by the tellurides and the wall not well defined.

It was thought in the early days of the camp that the dykes and veins in the granite were barren. Recently a pay vein in the granite not associated with a dyke has been found in the Home Run claim near Victor; and several veins have been found in the granite on the north slope of Tenderfoot hill which give promise of turning out well.

The normal contact of the andesite with the underlying granite has not been systematically prospected as yet, but should be tried even if at first sight the chances seem to be against finding pay ore. Such a contact if made by a faulting fissure has a high prospective value. The large and valuable ore body in the Independence in the southern district seems to fill these conditions.

Among the deeper mines are the Isabella, Victor, Anaconda, Moose, Elkton, Anna Lee, Independence and Portland. While I will not assert that the veins increase in size and value in depth, yet I can say that the deeper workings of the mines mentioned certainly show that the average vein is as profitable below as nearer the surface. The change to unoxidized ore in depth in this district is a matter of little note, for but a small part of the product is free milling ore, hence no check in the output is to be expected such as occurred in Leadville and Central City on reaching sulphides.

It is probable that a number of vents, through which the andesite was thrown up and spread out over the granite, exist in the district and they are probably of great extent, so that in many places deep sinking will continue to show andesite. In other parts the granite may be reached. In some of the deeper workings an increase in the included granite may be noticed, indicating an approach to the massive granite. When the vein arrives at the granite, the change of walls may influence the character of the mineralization, but there is no reason to believe that the vein will be cut off by the contact with the granite.

The boundaries of the district are not yet clearly defined and may be susceptible of considerable extension. Several outlying bodies of andesite are known, the Home Run mentioned above is a pay fissure entirely in the granite, and the new discoveries on the north slope of Mineral hill on phonolite dykes in the granite add largely to the possibilities in every direction. The territory now being actively worked is about six miles square.

For a time the wonderful discoveries in the southern portion of the district somewhat overshadowed the northern region, but during the current year a great increase in activity here has been noticed. The older mines such as the Isabella, Victor, Gold King, Union and others are sinking additional shafts, putting in heavier machinery, perfecting their surface improvements by extending their ore bins and sorting houses, and pushing extensive development work. Many new and important discoveries have been made, among which are the Brooklyn, Anchors, Midget and Geneva. More than a dozen new steam hoists have been erected on Gold hill since last February. The output both in tonnage and total value is steadily increasing and bids fair to double the product of the state in gold.

The camp is exceptionally well provided with facilities for the transportation and reduction of ore. The higher grade rock is sold to the great lead smelters at Denver and Pueblo. The medium grade product is sold to the two chlorination works at Gillette and Lawrence, and the two cyanide plants at Florence and Lawrence. The low grade surface ores are worked up in the local custom stamp mills by amalgamation and concentration with a fair degree of success. Transportation is provided by two railroads and good wagon roads in every direction.

To one looking back but a few years, the change from a peaceful cattle range to a group of a dozen cities and villages with a population of 12,000, the surrounding hills dotted with puffing hoists and substantial buildings, the air rent by the sharp blasts of giant powder and the roads blocked with endless processions of four-horse quartz teams, is marvellous, and a monument to western, and principally local, mining energy. The camp attracted but little attention in its beginning, partly on account of the fruitless stampede to Mount Pisgah some ten miles west in 1885. But an output of over $300,000 00 from one mine in one month and over $8,000,000 00 in gold in a year from the district, indicates the cause of this wonderful transformation.

Cableways for Open-Work Mining.

An interesting fact to contractors is revealed by the use of the various systems of handling rock on the Chicago Main Drainage Canal. A day's work for a man in filling lime stone into shallow skips, as used on the Lidgerwood cableway, averages between 16 and 17 cubic yards of rock in place for each ten hours' work, while the work of filling the cars, which are about 3' high, averages only about 9 cubic yards per man. This is a remarkable saving and alone would justify the use of the cableway in hundreds of localities. It may be mentioned in this connection that there are now twenty Lidgerwood cableways, which, by the way, are manufactured solely by the Lidgerwood Manufacturing Company, New York, in use in the construction of the Chicago Main Drainage Canal.

CABLEWAYS AT COAL STRIPPINGS.

The Suspended Cableway in Use for "Stripping" the Coal Seam at the Coleraine Colliery, Beaver Meadow, Pa.

The suspended cable system of hoisting and conveying has been in use for many years in slate and stone quarries, open work iron mines, excavating &c. For these purposes it has attained great popularity, and it is considered almost impossible to do without it. However, for "stripping," (removing ground and rock from the coal strata) it is but recently that its utility and and efficiency have been tested.

Messrs. Crawford & Dugan and Dick & Muntz, contractors at the Lehigh & Wilkes-Barre Coal Co.'s mines, were the first to introduce the system in the anthracite coal district. These operations were closely observed by all interested parties desirous of getting the best method by which the work could be accomplished. Although these plants were not erected to operate on a large scale, they demonstrated that the system met a long felt want, and because of its adaptability had come to stay, and to a certain extent take the place of the steam shovel.

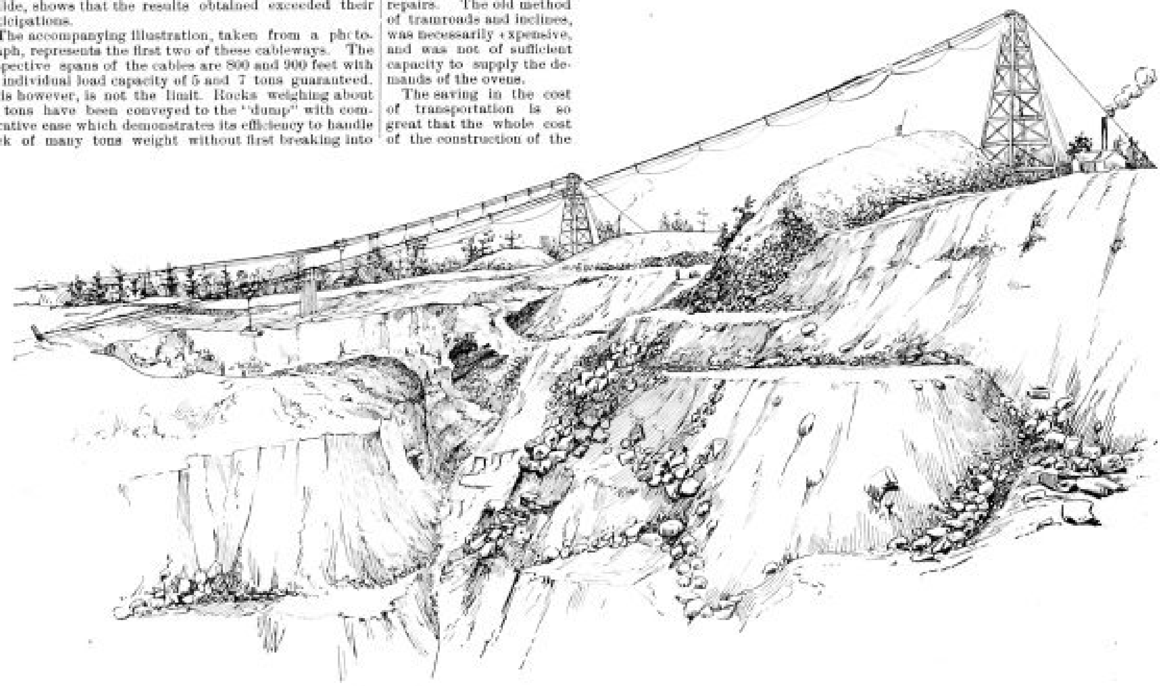
Mr. A. S. VanWickle adopted the cable system at his Coleraine Colliery, Beaver Meadow, Pa. and erected the first plant in the early part of last spring. The stripping at this place is quite extensive, and in order to remove the top as quickly as possible several more cables were erected during the summer. In starting a new place there are certain disadvantages, and while the conditions were unfavorable to work to the full capacity at the beginning, the expression of satisfaction by Mr. D. Levan Supt., and Purchasing Agent W. B. Wilde, shows that the results obtained exceeded their anticipations.

The accompanying illustration, taken from a photograph, represents the first two of these cableways. The respective spans of the cables are 800 and 900 feet with an individual load capacity of 5 and 7 tons guaranteed. This however, is not the limit. Rocks weighing about 10 tons have been conveyed to the "dump" with comparative ease which demonstrates its efficiency to handle rock of many tons weight without first breaking into smaller pieces as has been the practice for the steam shovel.

To handle smaller stones and ground, skips, or boxes are provided of suitable size.

The third plant at Coleraine is of the horizontal type. A 2¼ inch diameter steel cable having a clear span of 1000 feet is suspended from two towers one of which is 120 feet high. The amount of material handled with one of these plants depends on the conditions surrounding it. A fair average, however is from 300 to 500 cubic yards per day. Any doubt, or objection which may have existed as to their practicability has been dispelled, and other operators are adopting the system at their "strippings." Mr. E. L. Bullock, Supt. of the Dodson Coal Co.'s mines, Morea, Pa., is erecting a plant of the same capacity as those refered to above. For open pit mining, after the top has been removed, the system will no doubt greatly facilitate the work of taking out the coal.

The machinery, hoisting engines &c., for the plants refered to was furnished, and erected by S. Flory & Co., manufacturers, Bangor, Penna. who are prepared to furnish estimates for complete plants. Those contemplating the use of plants of this kind will find it to their interest to communicate with them.



CABLEWAYS AT COLERAINE COLLIERY STRIPPINGS.

About Pumps.

A rise in prices is indicative of two important facts: First that there is a strong demand for the article, and second that the quality of the article is of so high a grade that the producers do not fear the competition of of cheaper and inferior articles. The fact that The Laidlaw-Dunn-Gordon Co. has sent out notices to all its branch houses and agents throughout the country advancing prices fifteen per cent. is indicative of a heavy demand for Laidlaw-Dunn-Gordon pumps, and is also strong evidence of their superior qualities.

Written for THE COLLIERY ENGINEER AND METAL MINER.

A FLUME CONVEYOR.

COAL FOR COKE OVENS CONVEYED 8,400 FEET BY WATER.

Description of the Montana Coal and Coke Company's Method of Reducing the Cost of Handling Coal.

(By B. L. Lloyd, C. E.)

The Montana Coal and Coke Co., operating mines and a coking plant at Horr, Montana, completed in April last a flume for conveying the washed coal from the washer to the drying bins near the coke ovens. The flume is working very successfully to the first bins, which are 8,400 ft. distant from and 1,000 ft. lower altitude than the washer. New bins 1,200 ft. nearer the ovens have been constructed, and the flume has been extended to them. The flume is constructed over such rough ground, and has such a variety of grades and curves, that a description of it from its inception will no doubt prove interesting.

While the writer does not in any sense lay claim to the invention or conception of a flume for the purpose of carrying crushed or washed coal short distances on good grades, he does claim that the transportation of the output of a mine, except the lump coal, over a long distance and rough country to the coke ovens is a novelty. It is true, it is simply an application and extension of an old idea, but it is of such magnitude that it is worthy of notice. It is now transporting all the coal required for the coke ovens at a cost of simply the interest on the investment and very slight repairs. The old method of tramroads and inclines, was necessarily expensive, and was not of sufficient capacity to supply the demands of the ovens.

The saving in the cost of transportation is so great that the whole cost of the construction of the flume will be saved in a few months. It was the necessity for a greater supply of coal that led to the construction of the flume.

The location of the mines is at the southern terminus of the branch line of the Northern Pacific Railway, which leads from Livingston, Montana, to Cinnabar, the entrance to the Yellowstone National Park. We are about 5 miles from the line of the park, and are, therefore, in the Rocky Mountains. Our railroad station is on the banks of the "Upper Yellowstone," in the famous Yellowstone Canon. Only a few miles away is the Electric Peak, 12,000 feet high, while between the mining camp and the station is the "Devil's Slide." This is the out croppings of a perpendicular vein of the red ore of cinnabar, which is about 15 ft. thick, and which is flanked on either side by perpendicular walls of rock ranging from 75 to 150 feet high, and which extend from the top of Cinnabar Mountain to the foot, and form a sight well worth travelling a long distance to see. When the trains come by bringing tourists to the Yellowstone Park, they stop just before they reach our station, in order that the tourists may get a view of this beautiful sight. Our station is 5,200 feet above the level of the sea, while the mine workings are 1,100 feet higher. The works are situated relatively as follows: The washer is situated about 80 feet below the mouth of the mines and is the point of discharge into the flume. The loading track, under the former drying bins, is 95 feet lower. By the old method, in use when the writer came here, the coal was hauled by mules over a tramroad 4,500 feet long; thence, down an incline 1,300 feet long, which is at an angle of 22°; thence, over another tramroad 2,500 feet long; thence, down another incline 900 feet long, with an angle of 26°, to a bin; thence, it was hauled in a "larry" by a "dummy" engine (such as is used on street railways) down another tramroad with 3, 4 and 5% grades to the coke ovens.

When it was represented to Mr. John H. Conrad, the owner and manager of the mines, that, having the water at hand, a greater and adequate supply of coal for the ovens could be transported without cost by means of a flume, he, with the sagacity and promptness which characterizes him as well as the western mine manager generally, saw a good thing in it and ordered it put in at once.

When the writer ran the levels he found that there was 128 feet fall from the washer to the track at the first "divide", which is at the end of the first tramroad and the head of the first encline. This gave him a minimum gradient of 2.8% or 0.7 feet per station of 25 feet. This gradient he kept in mind during the balance of the survey. He made a reconnoisance of the ground, finding it rough on every route. One route which had been suggested to the Manager, and which followed in part an old pipe line and led finally down the last incline (which has an angle of 26°), was considered objectionable at first, from the fact that the flume was to be made of plank 2 inches thick, and of course jointed, and the incline being two-thirds trestle, the continued vibration would keep open the joints, which otherwise would fill up with fine coal, and because the coal and water coming down the angle of 26° into the settling tanks on top of the drying bins would necessarily keep the contents in a turmoil with little chance to settle. Therefore, a route going straight down the mountain following the side of the first long incline, (average pitch of 22°) and from the foot of this down a very steep ridge, and over a bluff, to the bottom was adopted. About 200 feet of this was on 45° grade or more. On reaching the bottom of the mountain, the grade was rounded out with a vertical curve by means of a trestle until the grade of the small branch which comes down near by was secured. This branch was then followed and good alignment and good grades, starting with 15% and gradually lessening until it got to about 6% were secured. The writer then went to the new drying bins and located the line back, using the same minimum grade as on top *viz.*; 2.8% and followed this until it crossed the line coming down the branch. Then the 6% grade was rounded into the 2.8%. Of course when following the minimum grade we took the best alignment we could get without to much grade work. It was side hill work. We only excavated on an average enough room for the boxes to rest on solid ground, making about half a dozen thorough cuts, and putting in about a dozen small trestles. Some of the curves were pretty sharp, but we figured that when we made a thorough cut or trestle, that the shortening of the distance would about even it up, and give enough compensation for the curves; the compensation required in this case being to increase instead of lighten the gradient.

Some of the "wiseacres" of course criticised the flume and were ready to say, "I told you so." They claimed that with such a diversity of grades it would never work; that the coal and water would travel faster on the very steep parts than on the minimum grade. This we did not dispute, but we held that while the speed was greater, the volume must be the same; that it could not go down the hill any faster than it got there over the long stretch of 4300 feet of minimum grade from the washer to the divide; and that after it got down the hill, it would travel as fast over the minimum grade of 1000 feet at the lower end as it did at the top. The successful behavior of the flume has proven that it will work beautifully on even as light a grade as 2.8% and that with an established minimum, care being taken not to get flatter than the minimum and to compensate even very lightly for curvature, it will work very nicely, no matter how steep some parts of it may be, and at almost any curvature.

As was mentioned above nearly all the grading that was done was on the side hills where we established the minimum grade. Pegs were set to grade at intervals of 25 feet, or on the "grade contour." As we commenced the work on the 4th day of March, the surveying was done before, and at a time when the ground was covered with snow and was frozen. It was found necessary to take a short drill along to make holes down into the frozen ground, using pegs a little larger than the drill, which went in tight and were set to grade.

The side hills were graded with the objects, first, of getting as much as possible solid ground bearing for the boxes; second, of covering up before cold weather to keep from freezing, the intention being to make embankments at the side and barely cover the top, it having been observed that the short flume from the washer to the former drying bins, which was covered the same way, did not freeze all last winter, and we had some pretty cold weather here.

Where we went straight down the mountain, the flume was built almost regardless of grades or curves. It was simply put in the quickest and most convenient place, some care being taken to get through the snow, and well into the ground with blocks at each joint. The intention being to put an embankment of earth at each side, and cover it with boards and some earth before cold weather comes.

The boxes were made of undressed 2 inch fir plank, having 8 inch bottoms and 10 inch sides thus giving an 8x8 opening. The sides were spiked to the bottom with 30-penny wire nails which were put at intervals of about 6 inches; and collars of 2″x6″ plank were fitted with some care at each joint and were put around the boxes at the center to keep them from warping or twisting. They were in lengths of 12, 14 and 16 feet, mostly 14 feet, and were generally cut in two, making short lengths to go around the curves. They were set at slight angles with each other to make the curves, or as the carpenters would say with a "bevel cut," which was as much in some cases as 4 inches in 24, or that much deflection from the line of the last box. To make the joints close, the boxes were set in position as they were intended to lay, in which position the "bevel cut" was measured and made; then being set end to end and leveled up to the required grade, a saw which had the teeth set wide was run down through the joints, cutting out where the boxes did touch the width of the saw set. If this did not make the joint tight it was repeated, often three or four times, until it was tight. Then the bottom piece of the collar being already on the front end of the last box and, the back end of the next box being fitted was spiked down to the collar piece. This held it in position for the man coming behind who put on pieces of 2″x6″ on either side after taking a chisel and making the sides of the joint smooth so that the peices would cover the joint and have a bearing on both boxes, then another piece of 2″x6″ was nailed across the top thus completing the collar. The joints could not be better. It was calculated that while at first a very little water might leak at the joints, they would soon fill up with fine coal, which was found to be the case, the flume not leaking at all now.

The trestles, not being in any places very high, were built of 4″ x 4″ stuff, with simply a cap piece 4 ft. long and two batter posts which were clapped into and "toe-nailed" to the cap piece. Where trestles occur it is intended to box in the flume with boards and fill in with saw dust.

The flume has almost exceeded our expectations. It is working beautifully. It carries over all the coal that is put into it without cost except interest on its construction.

In a few places where the "frost" was not all out of the ground, the flume settled some below the grade line, and would block up to a certain extent and overflow. But since we went over it and put it true to grade it has given us no trouble at all. This is like regulating the little details of machinery or any other mechanical contrivance, but we find that like some of them it is an important detail, and the grade must be set with great accuracy, and nowhere at less than the minimum. And where there is a long stretch of minimum grade we find that, as anticipated, a steeper grade for a short distance with the minimum on either side of it is nearly as bad as one too flat, by tending to cause pulsations in the flow at the bottom of this steep part. This is absent where the grade is uniform, or only compensated very lightly for curvature.

We also find the coarser part of the washed coal, or pieces as large as the end of the finger down to "buckwheat" size, travels the best, seeming to roll over the other and finer part. The most of our coal being fine it is harder to carry than if it were pea coal or buckwheat size. From 40 to 50 per cent. as it comes from the mines (miners are paid R. of M.) would be called "slack" coal in Eastern bituminous markets, and when put through the rolls at the washer, crushes to very fine coal. In fact one can take in his fingers the percentage mentioned above and wash it until it becomes almost as fine as meal. But it is the best coking coal in the State of Montana, and as we believe west of the Allegheny Mountains. It is used almost exclusively by the smelters in Butte City and Helena, and in Idaho. The management is contemplating building 100 more ovens in the very near future, and also to put in a large flume to carry over the lump coal as soon as the lumber can be gotten out.

Of course there must be settling tanks on top of the drying bins. Those in use here are built in pairs, over the bins, 6 ft. wide 6 ft. deep and the length of the bins with an overflow from first to second and from second to discharge spout. They are *not* built *level*, the end at which is the overflow being built 3 or 4 inches lower than the other end, and the second tank lower than the first of each pair. The coal comes from the flume and pours into the first tank. When this tank fills and the water first overflows, it is perhaps ½ full of coal, and the water overflowing from the first to the second, carries with it, in suspension, very fine particles of coal, almost as fine as flour. This will be carried over from the first on account of the turmoil, but will settle in the second, very little if any going out of the second tank. This is nearly as fine as flour, but will make as good coke as any; in fact it is claimed by the yard boss, that the finest specimen of coke coming off the yard was made from some of this very fine coal, put into a can and set in one of the ovens to burn.

The power used in our washer is a Pelton water wheel, the 18 inches No. 3 motor, having a head of 300 feet. This not only runs the machinery of the washer, the crushing, the elevating and the jigs, but supplies almost enough water to carry over the coal in the flume, and to carry off the rock discharge or waste.

The flume on all except the minimum grade was lined with sheet iron to prevent wear. It seems to be something like the "Kodak." You put in the coal and water and the flume "does the rest."

A NEW ELECTRIC COAL DRILL.

A Convenient and Efficient Portable Machine.

The application of electric machinery to mining is becoming more general every day. This is particularly the case in coal mining. Naturally in coal mining the most laborious operation in the getting of the coal is the drilling of the holes for blasting out the coal.

During the past year The Jeffrey Manufacturing Co., of Columbus, Ohio, has made some radical improvements in machinery designed to accomplish this laborious work. An electric power portable drill that is compact, strong and at the same time light enough to enable one man to handle it with ease has long been desired. The drill which we illustrate herewith combines all the best points

Jeffrey Improved Electric Coal Drill.

of the successful electric drills, formerly furnished by The Jeffrey Manufacturing Co., together with a number of new improvements. The motor running the drill is practically the same as on the other style of drill manufactured by The Jeffrey Company. The iron-clad armature, commutator, brush holder and in fact all the electrical parts are encased in a steel box-like casting which protects them thoroughly from mechanical injury and keeps them perfectly clean and dry.

The drill is universally mounted on a single post standard and can be easily turned to point in any direction by the loosening of a single nut. Holes can be drilled at any angle from vertical to horizontal. One of the great advantages of this single post is the increased range of adjustment; for instance, the drill illustrated can be worked in either, a vein 8′ 6″ thick or one 6′ thick, the extension screw covering the difference in height. Another advantage of the single post arrangement is that the drill can be placed much closer to the rib than is possible with any other type of frame. A very important improvement that has been made on this machine is the application of the friction screw feed by means of which the operator is given full control of the speed with which the drill is fed into the coal or material to be drilled. The drill can be fed at any speed from nothing to 9 feet per minute. Another advantage of this form of feed is that it thoroughly protects the drill, both mechanically and electrically, from injury as the feed is controlled entirely by the flexible friction band. The shock to the auger point in striking rock or iron pyrites (sulphur balls) is relieved by the yielding of the friction band allowing the nut to slip slowly, but at the same time continuing work; in other words, the rate of feed is decreased in a perfectly automatic and reliable manner the moment the bit strikes an extraordinarily hard material.

With these drills, as now arranged, there is a small reel carrying 300′ of concentric, rubber insulated, triple braided cable, connected at one end permanently to the reel; the other end having on it clamp hooks for attaching to the main electric conductors in the mine. A light truck having a false bottom in which to carry the extra augers, feed bars and tools is furnished to provide transportation from one part of the mine to another. When the driller finishes work in one room or chamber he places the drill on the truck, on which is also mounted the reel and cable, and pushes it into the next room which is to be drilled. When he gets to the room neck he takes the spring clamps on the end of the cable and hooks them on the main line, the cable on the reel unwinding as he goes along. After setting the drill at the face of the coal in its proper position he takes a short piece of cable, having insulated plugs on each end of it, and places the plugs one in each end of the reel and makes connections for drilling with the end of the cable to the motor. No rheostat or intervening starting apparatus is used. In this manner the operator is practically placed in an automatic position where everything is made for him and he has only to place certain things in certain positions and the machinery does the rest. It is very evident from a close examination of the drill illustrated and this description, that the Jeffrey Manufacturing Co. has devoted a great deal of time, expense and attention to the details of this machine and it is undoubtedly a successful and practical contrivance.

Pointers for Mine Managers.

With this number of The Colliery Engineer and Metal Miner, Messrs. Roberts, Throp & Co., of Three Rivers, Mich., begin an advertisement of a steel mining car wheel made by them. This wheel, which is very light compared with cast iron wheels of equal size, the manufacturers' claim is equal in every way to the severe demands of mining service. This firm also builds light cars of every description, and will gladly furnish full information as to their specialties on application. They have recently been distributing to their trade a very neat and convenient pocket-memorandum book and card case, which they will be pleased to send to mine superintendents and engineers on application, so long as their supply lasts.

The American Injector Co., of Detroit, Mich., begin with this number an advertisement of the U. S. injectors and brass goods made by them. This firm will be pleased to quote prices and give full information to all users of their class of goods in the mining trade, and we bespeak for them a share of the patronage and good-will of the mining fraternity.

The Chicago Fire Proof Covering Co., of 48 Franklin St., Chicago, announce in this issue that they make a special steam pipe covering for mine use, that has met with great favor and which is guaranteed. Well covered steam pipes at mines are not only desirable because they furnish dry steam and higher pressure to the engines, but when the pipes run underground they prevent the heat radiating from the pipe drying out the timber and disintegrating the roof. In fact good mine management demands the use of a good pipe covering both on account of economy and increased safety.

Water Tanks for mine supply are a prime requisite at every well managed mine. Where to get a good cedar tank is often a question that mine managers find hard to answer. The Williams M'f'g. Co., of Kalamazoo, Mich., make a specialty of tanks, and therefore make them cheaper and better than their competitors.

A good chain pulley block is one of the most convenient as well as the most necessary appliances around a well-equipped mine. There are many different varieties, but that style made by the Moore M'f'g. and Foundry Co., of Milwaukee, Wis., is notable for its strength, convenience and ease of operation.

Special Electrical Appliances for Mines.

Although The Ohio Brass Company has but recently made any special efforts to introduce its line of construction material, among mining companies, who are using electricity for traction purposes, yet the results which have so far been obtained are of the most pleasing character.

Among the largest installations recently made on which its material has been used may be mentioned the following: Blossburg Coal Company, Arnot, Pa.; Crozer Coal & Coke Company, Elkhorn, W. Va.; Great Kanawha Colliery Company, Mt. Carbon, W. Va.; St. Clair Company, Eagle, W. Va.; M. I. Davis Company, Eureka, W. Va.; Corona Coal & Coke Company, Corona, Ala.; Card Upson Coal Company, Shawnee, Ohio; Vinton Colliery Company, Vintondale, Pa.; Pulaski Iron Company, Eckman, W. Va.; Monongah Coal & Coke Company, Monongah, W. Va.

Engineering Views.

Engineering Views is the title of an exceedingly handsome album of half-tone view of bridges, blast furnaces, steel works, water works, mine tipples, coke plants, etc., designed by Messrs. Wilkins & Davison, engineers, Westinghouse, B'l'd'g, Pittsburgh, Pa. Though both young men, Messrs. Wilkins and Davison show in this album a scope of work, such as few of the older members of the profession can show. In point of magnitude, the album shows that the firm enjoys the confidence of the leading investors in industrial establishments in western Pennsylvania and Ohio.

Industrial Railways.

The Ansonia Brass & Copper Company, Ansonia, Conn., use industrial railways of 21½ inches gauge, designed by the C. W. Hunt Company, New York. The Thorndike Company, Thorndike, Mass., have also installed the Hunt system of narrow gauge railways for handling materials in their works.

Written for THE COLLIERY ENGINEER AND METAL MINER.

THE DRAINAGE OF FLOODED MINES.

The Self-dumping Water Tanks Used at Luke Fidler Colliery in Removing a Large Body of Water.

(By Baird Halberstadt, E. M.)

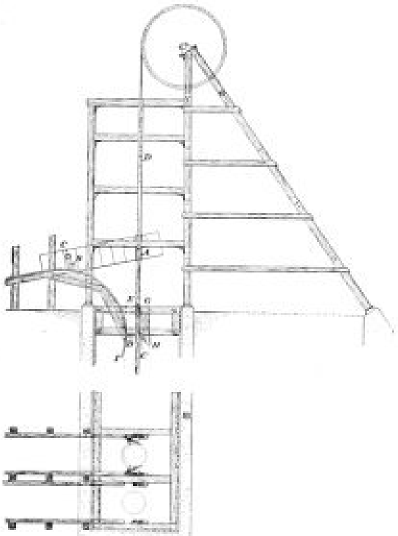
In an article on the fire at the Luke Fidler Colliery, Shamokin, Pa., in the August number of the COLLIERY ENGINEER AND METAL MINER, reference was made to the self-dumping water tanks used to assist in removing the water from the mine after the fire had been extinguished; and a description of them was promised in a later number.

The removal of water from mines by means of specially constructed tanks, as well as by utilizing old boilers or sections thereof, mounted on trucks for use in slopes, is by no means of recent origin. In most of these appliances however, the removal of the contents required from a comparative standpoint, too much time, whether the discharge was through valves either at the bottom or side near the bottom. The time lost, though seemingly short, amounted in twenty-four hours to considerable, and to obviate this a more rapid method of discharge was desired. At the Luke Fidler Colliery this was doubly necessary, since an immense body of water was to be removed, and to put the mine in working order as quickly as possible was of great importance. The conditions here were entirely favorable. The shaft was securely and finely timbered and the new shaft engines were of great power, developing a high rate of speed, yet through modern devices, such as steam brake and reversing appliances, under perfect control.

In the illustration we show the elevation and end view of the tanks now in use at this colliery. They are constructed of iron boiler plates ½″ in thickness. They are twenty feet long and four feet in diameter, with a capacity of 15,500 lbs. or over 1700 gallons each. When lowered to the water, a valve in the bottom of each tank is opened by the weight of the tank striking the water. When the tank it completely submerged, it is full of water, and the weight of this water closes the valve as soon as the hoisting begins.

Instead of discharging from valves either at the side or bottom, these tanks discharge from the top, the whole tipping over as shown and discharging the contents in a few seconds. The tanks are suspended in iron frames fastened at *A*, this frame passes along the guides and serves to keep the lower end of the tank along the guides, the upper part being held by guide wheels *B* and *C*.

The frame extends several feet above the top of the tank. At point *D* a strong bar of iron serves to keep these side bars apart; at the same point the spreader chains from the wire rope are connected. For a short distance below point *E* the guides are cut away. It will



DRAINAGE OF FLOODED MINES.

be noticed that a space is left between point *G* and the guide to permit the passage of the frame, but not sufficient for the guide wheel *C*, which passes through the guide, cut away below *G*. Guide wheel *B* then meets and runs along the T rail *I*, supporting the weight of the tank.

Under ordinary circumstances, the rapid and repeated discharge of so large a body of water would cause, in a short time, a serious washout. To prevent this the tanks discharge their loads into a wooden tank of sufficient size, from which the water is removed through an aperture in the side at the bottom.

From this tank to the creek below, wooden troughs are laid, the fall of the ground being too rapid to permit the water to run over the surface of the ground without serious washouts.

Dependent upon the height of the water in the shaft, these tanks discharged their loads at rates varying from 125 to 75 per hour.

A rate of 100 tanks per hour for thirteen consecutive hours was maintained and in that time 10,075 tons of water were removed.

The plan of hoisting water in tanks is in use at a number of the deep shafts in the region and it is claimed to give better results than could be obtained by pumping. In the matter of cost the advantage is said to be in favor of the tank system.

I wish to acknowledge the courtesy of Mr. Morris Williams, Supt. M. R. R. & M. Co., who planned these tanks, for kindly placing at my disposal the drawings from which the cuts have been made.

WILLIAM D. DODDS.

Almost a week after the terrible hotel disaster in Denver, Colo. in August, the writer was startled and grieved to read in his morning paper that "the body of William D. Dodds, of Albany, N. Y. was taken from the ruins of the Gumry Hotel yesterday. It was identified by a letter found in his pocket from his little daughter in Albany, across which he had endorsed 'Baby's first letter to Papa.' "

Affecting as this was to ordinary readers, it was doubly so to the writer, who was not only personally acquainted with Mr. Dodds, but who was also connected with him in a business way, as he was commissioned to represent THE COLLIERY ENGINEER AND METAL MINER in Colorado. At the time of his death Mr. Dodds had only been in Denver a few days, and had not commenced work.

He was born in Fayetteville, Ind. on January 12, 1854. His early life was spent in Indiana, Pennsylvania and Kansas. He was educated in the public schools, and later was under the private tutorage of his father, who was a Presbyterian clergymen in Topeka, Kansas. Early in life he was dependent on his own exertions, and it may be truly said, he was a self-made man. His first business experience was gained in clerical work. About fourteen years of his life was spent in Colorado and Montana, where he was connected in different capacities

WILLIAM D. DODDS.

with the mining industry. In 1890 he went to Granite, Montana, as assistant superintendent of the famous Granite Mt. Co., and later he became manager of the Elizabeth mine at Granite.

On August 31st, 1891 he married Miss Effie Russell Buck, of Albany, N. Y. who with one daughter, the "baby" whose little letter identified her father's body, survives him.

During the business depression in 1893, when silver mining came to a standstill, he with his family came east to Albany. In October of that year he accepted the position of superintendent of the Santa Lucia Mining and Milling Co's. mines in Honduras, Central America, where he remained one year. Upon his return to the United States he was employed by The Colliery Engineer Co. to assist in preparing Instruction Papers on gold and silver mining for The Correspondence School of Mines. This work was completed a short time before his death. After the completion of this work, he decided to go to Colorado and visit the principal mining camps with a view to seeking a location. While travelling through the State, he expected to act as a special agent for this journal. He was a man of very industrious habits, and in connection with his active work, was a deep student. Inside of two years he almost finished the Full Mining Course in The Correspondence School of Mines, and acquired a practical knowledge of the German and Spanish languages.

His moral character was above reproach. A consistent member of the First Presbyterian church of Albany, he rigidly adhered to the high moral standard expected of members of that denomination.

Written for THE COLLIERY ENGINEER AND METAL MINER

Ventilating Fans.

(By F. W. Sperr, Michigan Mining School.)

In Vol. XX. Transactions of the American Institute of Mining Engineers, pp. 642-3, Mr. R. Van A. Norris has published a table, giving the volumes of air delivered by a large number of different fans at various velocities. The results serve the interesting purpose of helping to ascertain the law of variation between the radial velocity of the air and the number of revolutions of the fan. If we let n represent the number of revolutions of the fan per unit of time and V the volume of air delivered, V will vary as some power of n, the general equation being $n_1^x : n_2^x :: V_1 : V_2$.

The radial velocity of the air varies as the volume. Then, for No. 1 fan, A and B, $84^x : 100^x :: 236.684 : 336,862$; and therefore, $X \log. 84 + \log. 336862 = X \log. 100 + \log. 236.684$.

$$\therefore X = \frac{\log. 336,862 - \log. 236,684}{\log. 100 - \log. 84} = 2.02$$

$$B \text{ and } D,\ X = \frac{\log. 347,396 - \log. 336,862}{\log. 111 - \log. 100} = .29.$$

$$D \text{ and } E,\ X = \frac{\log. 394,100 - \log. 347,396}{\log. 123 - \log. 111} = 1.23.$$

Average value of X for the double fans = 1.18.

For F and G, the single fan

$$X = \frac{\log. 247,876 - \log. 188,888}{\log. 130 - \log. 100} = 1.48.$$

$$\text{No. 2, } A \text{ and } B,\ X = \frac{\log. 82,969 - \log. 59,587}{\log. 83 - \log. 59} = .97.$$

$$\text{No. 3, } A \text{ and } B,\ X = \frac{\log. 137,760 - \log. 49,611}{\log. 70 - \log. 40} = 1.82.$$

For No. 4 fan we have only one observation published, and no comparison can be made.

$$\text{No. 5, } A \text{ and } B,\ X = \frac{\log. 147,232 - \log. 68,337}{\log. 50 - \log. 28} = 1.32.$$

$$B \text{ and } C,\ X = \frac{\log. 205,761 - \log. 147,232}{\log. 69 - \log. 50} = 1.04.$$

$$C \text{ and } D,\ X = \frac{\log. 299,600 - \log. 205,761}{\log. 96 - \log. 69} = 1.14.$$

Average value of X = 1.17.

$$\text{No. 6, } A \text{ and } B,\ X = \frac{\log. 92,160 - \log. 66,560}{\log. 100 - \log. 80} = 1.46.$$

$$B \text{ and } C,\ X = \frac{\log. 109,440 - \log. 92,160}{\log. 120 - \log. 100} = 1.19.$$

Average value of X = 1.32.

There is but one observation published for No. 7 fan, and one for No. 8.

$$\text{No. 9, } A \text{ and } B,\ X = \frac{\log. 277,380 - \log. 234,830}{\log. 55 - \log. 46} = 0.93.$$

$$\text{No. 10, } A \text{ and } B,\ X = \frac{\log. 194,200 - \log. 134,602}{\log. 73 - \log. 66} = 3.63.$$

$$\text{No. 11, } A \text{ and } B,\ X = \frac{\log. 215,200 - \log. 177,280}{\log. 180 - \log. 150} = 1.06.$$

$$\text{No. 11½, } A \text{ and } B,\ X = \frac{\log. 257,520 - \log. 217,338}{\log. 50 - \log. 45} = 1.61.$$

$$\text{No. 13, } A \text{ and } B,\ X = \frac{\log. 57,120 - \log. 28,896}{.301030} = .98.$$

$$B \text{ and } C,\ X = \frac{\log. 66,640 - \log. 57,120}{.096910} = .87.$$

$$C \text{ and } D,\ X = \frac{\log. 73,080 - \log. 66,640}{\log. 30 - \log. 25} = .50.$$

$$D \text{ and } E,\ X = \frac{\log. 94,080 - \log. 73,080}{\log. 35 - \log. 30} = 1.26.$$

$$E \text{ and } F,\ X = \frac{\log. 112,000 - \log. 94,080}{\log. 40 - \log. 35} = 1.30$$

$$F \text{ and } G,\ X = \frac{\log. 132,700 - \log. 112,000}{\log. 50 - \log. 40} = .76.$$

$$G \text{ and } H,\ X = \frac{\log. 173,600 - \log. 132,700}{\log. 60 - \log. 50} = 1.47.$$

$$H \text{ and } I,\ X = \frac{\log. 203,280 - \log. 173,600}{\log. 70 - \log. 60} = 1.02.$$

$$I \text{ and } J,\ X = \frac{\log. 222,320 - \log. 203,280}{\log. 80 - \log. 70} = .67.$$

Average value of X = .87.

No. 14 and 15 have but one observation published for each.

$$\text{No. 16, } A \text{ and } B,\ X = \frac{\log. 117,573 - \log. 84.149}{\log. 80 - \log. 58} = .32.$$

$$\text{No. 17, } A \text{ and } B,\ X = \frac{\log. 98,512 - \log. 85,285}{\log. 80 - \log. 70} = 1.08.$$

$$B \text{ and } C,\ X = \frac{\log. 107,300 - \log. 98,512}{\log. 90 - \log. 80} = .73.$$

Average value of X for No. 17 fan = .90.

$$\text{No. 18, } A \text{ and } B,\ X = \frac{\log. 29,498 - \log. 17,640}{\log. 52 - \log. 26} = .74.$$

$$B \text{ and } C,\ X = \frac{\log. 51,842 - \log. 29,498}{\log. 104 - \log. 52} = .81.$$

Average value of X for No. 18 fan = .78.

The observations on No. 19 fan were not fairly made, as explained in the note, and we shall not consider them here.

The observations on No. 20 fan were made on different mine orifices, and, therefore, do not answer the purpose in hand.

$$\text{No. 21, } A \text{ and } B,\ X = \frac{\log. 201,135 - \log. 177,855}{\log. 110.8 - \log. 88.6} = .55.$$

The average value of X for all these observations is 1.14, and it will probably be found to be unity by more extended and careful determinations; or, in other words, the radial velocity of the air varies as n.

EXAMINATION QUESTIONS ANSWERED.

THE EXAMINATION OF CANDIDATES FOR CERTIFICATES AS MINE FOREMEN,

Held in the Office of the State Mine Inspector at Birmingham, Alabama on October 26th and 27th, 1894.

(Continued from July, 1895.)

QUES. 22. What is the safe working load of a steel rope $1\frac{1}{8}$ inches in diameter?

ANS. Multiply the square of the diameter of the rope in inches by 9.4, and the result will be the safe working load in tons, as $\frac{9}{8} \times \frac{9}{8} \times 9.4 = 12$ tons nearly.

QUES. 23. What is the pressure per square foot at the foot of a stand pipe filled with water to a height of 105 feet?

ANS. As a cubic foot of water weighs 62.5 pounds, the pressure must be, $62.5 \times 105 = 6562.5$ pounds per square foot.

QUES. 24. If a water-gauge of 2 inches passes 15,000 cubic feet of air per minute, what water-gauge will pass 30,000 cubic feet per minute in the same air-way?

ANS. As the air-way is the same, a double quantity will be the result of doubling the velocity, and as the pressures vary as the squares of the velocities, the water-gauge will be $\frac{30,000^2}{15,000^2} \times 2 = \frac{30^2}{15^2} \times 2 = \frac{6^2}{3^2} \times 2 = \frac{2^2}{1^2} \times 2 = 8$ inches of water-gauge for the increased quantity.

QUES. 25. If two horse-power passes 14,000 cubic feet of air per minute, how much must the power be increased to double the quantity?

ANS. In the same air-way, the powers vary as the cubes of the quantities; and as the quantity has to be doubled the power in the second case must be as the cube of 2 multiplied by 2 the power for 14,000 as $2^3 \times 2 = 8 \times 2 = 16$ horse-power to circulate $14,000 \times 2 = 28,000$ cubic feet of air in the second case given.

QUES. 26. If you have two air-ways under the same pressure, one $6' \times 6' \times 5,000'$, the other $8' \times 4\frac{1}{2}' \times 5,000'$, which will pass the greater quantity and why?

ANS. Call the air-way $6' \times 6'$ A, and the other $8' \times 4\frac{1}{2}'$ B, then as the areas of section are both equal to 36 square feet and the lengths are both 5,000 feet it follows that the airway that encloses one of the equal areas with the largest perimeter, will offer the greatest resistance; and as the velocities (or quantities in this case) vary as the square roots of the resistances inversely, and as B's perimeter is larger than A's, if A's quantity is 1, that of B must be $\sqrt{\frac{p}{P}} = q$, taking A's perimeter as p and B's perimeter as P and B's quantity as q or, $\sqrt{\frac{(6+6+6+6)}{(8+8+4\frac{1}{2}+4\frac{1}{2})}} = \sqrt{\frac{24}{25}} = .97985.$

QUES. 27. What is the horse-power of an engine, the cylinder being $15''\times20''$ running 175 revolutions per minute, the effective steam pressure being 60 pounds per square inch?

ANS. If the total pressure on the piston in pounds per square inch, be multiplied by the piston speed in feet per minute, the result will be the units of work per minute done by the engine, and if the units of work per minute are divided by the units of work in one horse-power that result will be the answer required, namely, the horse-power of the engine; as

$$\frac{(15 \times 15 \times .7854 \times 60) \times 20 \times 2 \times 175}{33,000 \times 12} = 187.42 \text{ or}$$

187.42 H. P. the answer required.

QUES. 28. Your main-entry from bottom of second shaft runs due north 3,600 feet. A cross-entry is started due east at a distance of 200 feet from the face and driven 2,465 feet. What length of roadway started 250 feet from shaft will be required to connect with the face of the cross-entry?

ANS. The base of the right angle triangle in this case measures 3600 feet, minus the distance from the face plus the distance from the shaft, that is $200 + 250 = 450$, then $3600 - 450 = 3150$. The perpendicular of this triangle is 2465 feet, then

$\sqrt{2465^2 + 3150^2} = 3999$ feet nearly, the length of the roadway required.

QUES. 29. In approaching an abandoned mine filled with water, 400 feet deep, how large a pillar would you leave to be safe, the seam being 7 feet thick?

ANS. In a soft bituminous seam 7 feet thick, and at a depth of 400 feet I would leave a barrier pillar 95 feet, or $31\frac{2}{3}$ yards thick.

In the anthracite region of Pennsylvania, the accepted rule for the thickness of barrier pillars, is: Multiply the thickness of the workings (in feet), by one per cent. of the depth from water level (in feet), and add to this product, 5 times the thickness of the workings (in feet) and the result is the thickness of the barrier pillar in feet. For a soft bituminous coal, $1\frac{1}{2}$ time the thickness provided by the anthracite rule has been taken.

QUES. 30. A shaft employes 800 men, 85 day hands, and 35 mules. How many cubic feet of air per minute would be required according to law?

ANS. The provisions of the State of Alabama Mining Law, Section 24, read as follows: "Be it further enacted; That the owner, agent or operator of every coal mine, whether worked by shaft, slope or drift, shall provide and hereafter maintain for every such mine sufficient ventilation for each and every person employed in such mine, which shall be circulated around the main headings, cross headings and working places to an extent that will dilute, render harmless and carry off noxious and dangerous gases generated therein." Where no gas is generated we would therefore allow as a minimum 100 cubic feet of air per man employed in the mine, and per mule 300 cubic feet, therefore under these conditions the total would be

800 at 100 per man	80,000
85 at 100 per man	8,500
35 mules at 300 per head	10,500
Total	99,000

If the mine generated much gas, I would allow 300 cubic feet of air per minute per man, as

800 at 300 per man	240,000
85 at 300 per man	25,500
35 mules at 900 per head	31,500
Total	297,000

QUES. 31. When rooms are to be driven from the entry at an angle of 45°, what distance must they measure from center to center in the entry, to make the rooms 25 feet in width, and leaving between them pillars 15 feet thick?

ANS. Divide the breadth of the room and pillar by the sine of the angle the room and the pillar makes with the entry, and the result will be the distance between the rooms center and center as $\frac{(25+15)}{\sin 45°} = \frac{40}{.7071} = 56.561$ feet; or the opening of the room by the side of the entry is $\frac{25}{.7071} = 35.348$ feet, or the measure of the pillar along the side of the entry is $\frac{15}{.7071} = 21.213$ feet.

QUES. 32. How many gallons of water will a circular shaft 8 feet in diameter, and 16 feet deep contain, and how long will it take an 8-inch pump having a velocity of 100 feet per minute to empty it?

ANS. The contents of the shaft are

$8 \times 8 \times .7854 \times 16 \times 7.48 = 6015.787$ gallons, and the time occupied by the pump in emptying the shaft will be found as follows: Let 8 inches equal $\frac{2}{3}$ of a foot, then, $\frac{8 \times 8 \times .7854 \times 16}{\frac{2}{3} \times \frac{2}{3} \times .7854 \times 100} = 23.04$ minutes, or the shaft would be emptied in 23.04 minutes.

QUES. 33. How many 2-inches pipes will it take to supply an 8-inch pipe?

ANS. The pipes are supposed to be equal in length, for no lengths are given, and as the velocities vary as the square roots of the resistances inversely, it follows that the velocity through the small pipe will only be equal to

$$\sqrt{\frac{8 \times 3.1416}{8 \times 8 \times .7854} \div \frac{2 \times 3.1416}{2 \times 2 \times .7854}} = \sqrt{\tfrac{1}{2} \div \tfrac{2}{1}} = \tfrac{1}{2}.$$

The velocity then through the 2-inch pipe, will be $\frac{1}{2}$ of that through the 8-inch pipe, and as 16 two-inch pipes have a joint area of 64 circular inches, and one 8-inch pipe has an area of 64 circular inches, it is clear that as the velocity through the 2-inch pipes is only $\frac{1}{2}$ of that through the 8-inch pipe, it will require 32 two-inch pipes to supply an 8-inch pipe.

Mine Foremen's Examination in the Bituminous Fields of Pennsylvania, Jan. 22, 1895.

QUES. 1. Write an essay in detail explaining the use of dynamite in blasting. Is frozen dynamite fit for use? If so, or if not, say how you would treat it?

ANS.—Dynamite is one of the strongest explosives used for blasting in mines, and is a *shattering* compound contrasted with gun-powder, or blasting-powder. The latter is a *rending* explosive preferred for breaking coal. The efficiency of dynamite for breaking stone depends on the correct adjustment of the diameter of the shot hole, the position of the drill hole in reference to joints in the rock, and the best angle that the axis of the hole should make with the plane of the face.

The weights of the cartridges require adjusting to the work to be done, and the blaster should understand that the weights of the charges in ounces should be proportionate in inches to the cubes of the lengths of the lines of the least resistances in the rock to be broken. Detonators should either be of sufficient strength to fire every cartridge used, or detonators should be provided for cartridges of greater and lesser weights or otherwise primer cartridges should be used to fire the large cartridges. Great care must be taken in fixing the detonator within the end of the plug of dynamite or in securing the detonator to the end of the cartridge, so that it may not be dislodged during the progress of stemming; further, if the firing is by electricity, then judicious care must be taken not to use such stemming as consists of angular particles of hard stone with sharp cutting edges, otherwise they cut through the insulation, and either short circuit the current or cause leakages; and in either case the chances of misfires are increased in number.

The stemming should be done with rough round sand, or clay for upward or side holes; water will often be sufficient for downward holes in wet ground.

Detonators are sometimes fired with powder thread fuses, but oftener by electricity. In electric firing, care must be taken to use just such magneto-electric machines, as supply a current of sufficient strength to fire a given number of shots simultaneously in circuit.

Frozen dynamite is dangerous to handle, as the tritrition of its particles is sufficient to explode it; it therefore should be kept warm or at a temperature equal to that of the human body. In the event of its being frozen, it should be warmed by being placed near a hot water pipe or steam pipe, but it should never be heated beside a body whose temperature exceeds 212° F.

QUES. 2. Is machine mining safe when the mines are dry and produce firedamp? Is it safe to use electric motors in machine mining? and do you think machine mining is safe where there is no gas?

ANS. When the mines are dry and produce fire-damp, machine mining is no more unsafe than when mining is done by ordinary methods. Compressed air cannot be a source of danger, nor can electricity, for all sparking can be prevented by using alternating currents, and polyphase motors that are absolutely sparkless, as there are no commutators and it is impossible, from the design of these machines, for them to produce a spark; therefore the three points in the question are answered by saying: No increase of danger can arise in mines that are dry and produce fire-damp, by using machines for mining. It is quite safe to use electric polyphase motors actuated by alternating currents for machine mining.

There is nothing in machine mining that can be a source of danger when the roof and the floor will allow the machine to cut along a timberless face.

QUES. 3. What would you consider a good grade for a haulage road and a water way?

ANS. A fall to the shaft or slope of 1 in 150, would be a good grade for a haulage road or a water way in a bituminous mine.

QUES. 4. A circular sump 20 feet in diameter and 25 feet in depth, is full of water. What is the quantity in gallons and cubic feet? If a double acting steam pump, with a water cylinder 9 inches by 18 inches was set to pump, how many strokes would be necessary to empty the sump?

ANS. The cubic feet of water in the sump are $.7854 \times 20 \times 20 \times 25 = 7854$ cu. ft. The gallons of water in the sump are $7854 \times \frac{1728}{231} = 58,752$ gallons. The theoretical number of cubic inches of water discharged at each single stroke of the pump is $.7854 \times 9 \times 9 \times 18 = 1145.1132$, and allowing 10 per cent. for the slip of the pump, the actual number of cubic inches of water discharged by each stroke is $1145.1132 \times .9 = 1030.60188$, and the number of single strokes of the pump to empty the sump is $\frac{7854 \times 1728}{1030.6} = 13168.84.$

QUES. 5. A bore-hole from the surface is 6 inches in diameter and enters a rib fall in the mine. A mixture of 50 per cent. CH_4 and 50 per cent. of air is passing up the hole with a velocity of 130 feet per minute. What is the volume in cubic feet? and what would be the volume if sufficient air was added to bring the mixture up to the highest explosive point?

ANS. In the first case the volume passing up the bore-hole is equal to $\frac{.7854 \times 6 \times 6 \times 130}{144} = 25.5255$ cubic feet per minute.

In the second case, 9.5 parts of air to one of CH_4 is the maximum explosive mixture, and as the mixture already consists of equal volumes of gas and air; the unit volume of the gas is $\frac{25.5255}{2} = 12.76275$ cubic feet; the volume of air required will be $12.76275 \times 9.5 = 121.246125$, and the volume demanded that contains sufficient air and gas to make the maximum explosive mixture, is equal to $12.76275 \times 10.5 = 134.008875$ cubic feet of a mixture of 9.5 of air to 1 of gas or CH_4.

QUES. 6. If the bore-hole in the above question was allowed to remain closed up for 12 hours what would be the volume of the gas at the end of the time, and what would the volume be if sufficient air was added to make a maximum explosive mixture, and what volume of air should be added to the gas to make it a harmless mixture?

ANS. The volume of fire-damp CH_4, that would accumulate in 12 hours would be equal to, $12.76275 \times 60 \times 12 = 9189.18$ cubic feet. The volume of the maximum explosive mixture of 9.5 of air to one of gas, would be equal to $9189.18 \times 10.5 = 96486.39$ cubic feet.

To make the mixture harmless, I would mix 30 of air with one of gas, and therefore the air required to make 9189.18 cubic feet of CH_4 perfectly safe would be $9189.18 \times 30 = 275675.4$ cubic feet.

QUES. 7. What would be the cost of an overcast containing the following material, and having spent on it for labor the following amounts?

6½ cubic yards of stone at	$1.05	per yard
5,250 bricks at	6.25	per thousand
35 bushels of lime at	.0775	per bushel
70 bushels of sand at	.0625	per bushel
10 days masonry at	2.25	per day
10 days attending masonry at	1.60	per day
37 days taking down slate and delivering material at	1.50	per day

ANS.—

6½ cubic yards of stone at $1.50 per yard	$ 4.9250
5250 Bricks at $6.25 per thousand	32.8125
35 bushels of lime at .0775 per bushel	2.7125
70 bushels of sand at .0625 per bushel	4.3750
10 days masonry at $2.25 per day	22.5000
10 days attending masonry at $1.60 per day	16.0000
37 days taking down slate and delivering material at $1.50 per day	55.5000
The cost of the overcast will be	$138.72½

QUES. 8. What are the indications sometimes met with at the face of working places, which should serve as a warning that you are approaching old workings, and what precautions would you take to provide for security and safety under the circumstances?

ANS.—In approaching old workings containing water and gas at a high pressure, water is seen running out above and beneath, and through the coal. When the old workings do not contain water, the danger arising from gas is considerable, as the danger is on you unexpectedly, and when the old workings contain water not more than roof high, the danger is very great, because the water seldom gives warning.

Whether the old workings give warning by bleeding or not the Act relating to The Bituminous Coal Mines of Pennsylvania, provides by Section 3, Article V.

"In any place that is being driven towards, or in dangerous proximity to an abandoned mine or part of a mine suspected of containing inflammable gases or which may be inundated with water, boreholes shall be kept not less than twelve (12) feet in advance of the face and on the sides of such working places, said side holes to be drilled diagonally not more than eight (8) feet apart; and any place driven to tap water or gas shall not be more than ten (10) feet wide, and no water or gas from an abandoned mine or part of a mine and no borehole from the surface shall be tapped until the employes except those engaged at such work are out of the mine, and such work to be done under the immediate instruction of the mine foreman."

Should the proximity of the old workings be unknown and water is bleeding out of the advancing face, then no further advance should be made without boring according to the provisions of Section 3.

[TO BE CONTINUED.]

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for any fancied want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Correction.

Editor Colliery Engineer and Metal Miner:

SIR:—Answer (2) to questions asked by A. P. Smith, Chico, Mont., published in your July issue should have been supplemented with the following:

This is the theoretical velocity and orifice necessary to discharge the required quantity, but in consequence of the contraction of the stream a short distance from the orifice, the velocity of efflux is slightly reduced from the theoretical value, and the quantity discharged is greatly reduced, friction also reduces the speed. In order to allow for these losses Budge gives the following rule:

$$D = 0.497 \sqrt[5]{\frac{L \times W^2}{H}} = 23.35'' \text{ diam. of pipe} = 20.7''$$

square flume.

D = Diameter of pipe in inches.
H = Head of water in feet.
L = Length of pipe in feet.
W = Cubic feet of water discharged per minute.

Eytelwein's formula gives $D = 0.538 \sqrt[5]{\frac{L \times W^2}{H}} =$ 25.29″ diam. of pipe = 22.5″ square flume.

Hoping that you will make this correction. I am

Yours etc.,
STEPHEN H. NORTHEY.

The 5th Root.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following in your valuable paper in answer to question given by A. McDonald, Port Morien, in your August, 1895 issue.

The following is the formula worked out showing the method employed to extract the 5th root of a number.

Then let $(3)^{\frac{2}{5}} = \sqrt[5]{3^2} = \sqrt[5]{9} = \sqrt[5]{9.0000000000}$ 1.55+

```
                                   1
         5×10⁴ = 50000     800000
     10×10³×5 = 50000
     10×10²×5² = 25000
      5×10×5³ = 6250
           5⁴ =   625      659375
              131875 | 14062500000
  5×150⁴        = 2531250000
  10×150³×5²  =  168750000
  10×150²×5³  =    5625000
   5×150×5³   =      93750
        5⁴   =        625   13528596875
          2705719375 |      533903125
```

In the above the root is only extracted to two decimal places, but by a continuation of the above it can be be extended to the required number.

Yours etc.,
ARCHIE LAFFERTY,
Wampum, Pa.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for October.

QUES. 181. I am about to invent a new miner's safety lamp, and I intend to make the capacity of the tank or oil vessel large enough to supply sufficient vegetable oil for a consumption of 8 cubic inches per day of 10 hours, and as I require your valuable assistance, will you answer me three questions, as follows:?

1. What volume of air will be required to supply the necessary oxygen to burn the oil?

2. If only 20 per cent. of the oxygen of the air entering the lamp is consumed, what volume of air is necessary to feed this flame?

3. If, after allowing for the *vena contracta* and the interference of the wires, the available aperturage is in the ratio of .3, and if the velocity of the air on entering is equal to 3 feet per second, how many square inches of gauze covered entrance must I provide for the admission of air?

QUES. 182. We have found a large fault in one of our coal seams, and the cheeks or sides are 6 inches apart, and the interspace or vein is filled with calcite and galena. Our mine foreman says that galena always contains gold and silver, and his statement has so excited me with surprise that I have been trying to extract the metal by raising the ore to a high heat on an open fire, but it all wasted away in white smoke. I will, therefore, be obliged to you if you will tell me what I must do to obtain about seven pounds of the metal, and while you are busy please say what I must do to separate the silver from the lead.

QUES. 183. We have 1,000 acres of a seam of good and clean coking coal, 2 feet, 10 inches thick, and at an average depth from the surface of 600 feet: the roof consists of 30 inches of bad shaley coal, or bone; the mean inclination or dip of the seam is 4° 15′ to the east. How do you think I should work this seam to obtain all the coal, as I can only sink the shafts on the western side of the estate, the eastern side being all under water?

QUES. 184. I am engaged by a powerful syndicate to be the chief of a large staff of prospectors to search for useful minerals in Asiatic Turkey, and my instructions are to confine the work to be done to the valleys of the great rivers, the Euphrates and the Tigris, and the valleys of their tributaries, the reason for the restriction being, that the country is not opened up with railways, and therefore the water-ways are the only routes open for transport. In the North of Asia Minor where the great rivers take their rise the stratified rocks belong to the Cenozoic period, and nearly all the exposed rocks found in the valley of the Levant belong to the Mesozoic period such as those that are found on the east of the Tigris and the west of the Euphrates, and between the great rivers, as west of the Tigris and east of the Euphrates, the rocks are mostly of the Eozoic age, although rocks of later ages are found in patches. Now the great stone records of Babylon and Nineveh are cut on slabs of gypsum taken from their near hand quarries, and I will be obliged if you will give me such information as I require.

First.—We know that salt, coal, lignite, copper, lead, silver, gold, and iron abound within the rocks of the valley of the Levant, then please tell me where to send my men to search for them.

Second.—Tell me briefly what class of tools I ought to give each set of prospectors to find the particular minerals they will be sent in quest of?

QUES. 185. As I am anxious to obtain a good example of a magnetic survey. Will you give me your notes of one where the figure only has seven sides, also the plot, and the results of the traverse to prove its accuracy?

QUES. 186. We have a pump that forces with two six inch plungers the drainage water of the mine to an elevation of 660 feet. From the commencement this pump had a heavy "knock" and it was found to occur at the moments when the plungers began their advance on the forcing stroke and it seemed to result from the chambers not being filled close with water during the suction or intake stroke, and the consequence was the knock by the plunger advancing on the force, and the heavy strain that destroyed the packing of the glands and ultimately the "skin" of the plungers that became scored and fluted. Some mechanical engineers declared that the cause of the knock was the softness of the iron plungers that became fluted and leaky, and that the only cure would be in getting nickel steel or bronze plungers; our engineer, however, thought differently and said the only cure would be found in soaking the glands and drowning them with water. He then fixed cases over the outsides of the glands and filled them with water when the knock was completely cured. Will you then explain to me the cause of the knock and how or by what means it was cured by drowning the glands?

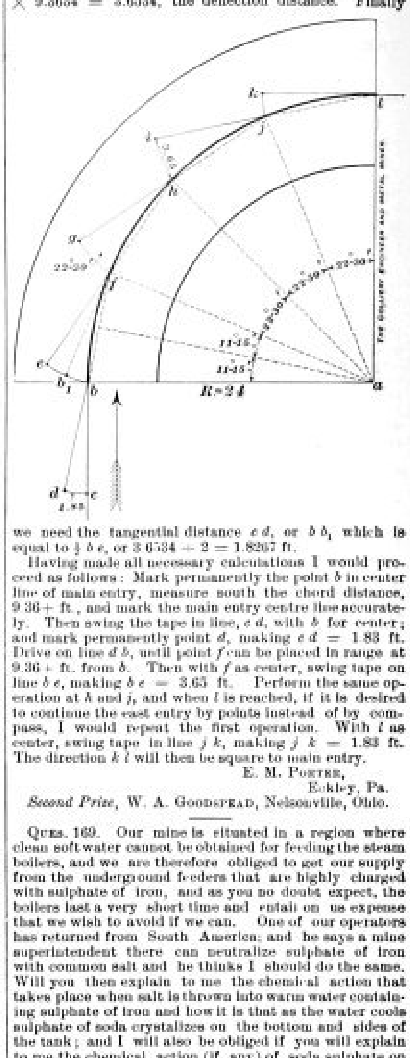
Solutions to Questions which Appeared in the August Number, and for which Prizes Have Been Awarded.

QUES. 166. For an extension of the haulage in a coal seam we are about to make a branch road going due east from the main entry and going due north from the shafts. Now the junction of the branch road with the main road has to be done with a curve of 24 feet radius, and as I would like to show off a bit with this curve, will you give me a plan showing how to set up the center lines with chords, and the fewest angular measurements required for a complete quadrant, the curved road being 12 feet wide?

ANS. To plan the road without the aid of a transit instrument, I would draw it to a large scale, say 1 inch to 10 feet, and divide the quadrant into four equal parts of 22° 30′ each. This is the least number of *equal* parts into which it may be divided for the purpose.

The chord of each arc, as $b\,f$, $f\,h$, etc., will be two times the sine of ½ the angle multiplied by radius, or 9.3634 ft.

The deflection distances, $b\,e$, $f\,g$ and $h\,i$, are equal to two times the sine of ½ the angle $b\,f\,e$ multiplied by $b\,f$. The angle $b\,f\,e$ being equal to the central angle $b\,a\,f$, then we have ½ $b\,f\,e$ = 11° 15′. Twice the sine of 11° 15′ × 9.3634 = 3.6534, the deflection distance. Finally



we need the tangential distance $c\,d$, or $b\,b_1$ which is equal to ½ $b\,e$, or 3.6534 ÷ 2 = 1.8267 ft.

Having made all necessary calculations I would proceed as follows: Mark permanently the point b in center line of main entry, measure south the chord distance, 9.36+ ft., and mark the main entry centre line accurately. Then swing the tape in line, $c\,d$, with b for center; and mark permanently point d, making $c\,d$ = 1.83 ft. Drive on line $d\,b$, until point f can be placed in range at 9.36+ ft. from b. Then with f as center, swing tape on line $b\,e$, making $b\,e$ = 3.65 ft. Perform the same operation at h and j, and when l is reached, if it is desired to continue the east entry by points instead of by compass, I would repeat the first operation. With l as center, swing tape in line $j\,k$, making $j\,k$ = 1.83 ft. The direction $k\,l$ will then be square to main entry.

E. M. PORTER,
Eckley, Pa.

Second Prize, W. A. GOODSPEAD, Nelsonville, Ohio.

QUES. 169. Our mine is situated in a region where clean soft water cannot be obtained for feeding the steam boilers, and we are therefore obliged to get our supply from the underground feeders that are highly charged with sulphate of iron, and as you no doubt expect, the boilers last a very short time and entail on us expense that we wish to avoid if we can. One of our operators has returned from South America; and he says a mine superintendent there can neutralize sulphate of iron with common salt and he thinks I should do the same. Will you then explain to me the chemical action that takes place when salt is thrown into warm water containing sulphate of iron and how it is that as the water cools sulphate of soda crystalizes on the bottom and sides of the tank; and I will also be obliged if you will explain to me the chemical action (if any) of soda sulphate on the shell of the boiler.

ANS. The chemical action to which the question refers proceeds as follows:

$$Fe\,SO_4 + 2\,Na\,Cl = Na\,SO_4 + Fe\,Cl_2.$$

Soda sulphate then remains in solution in the hot water and crystallizes from saturation, as when the water cools. Sulphate of soda produces no injury on the shell of the boiler, but does good in removing lime scale.

J. JENKINS,
Dingess, W. Va.

Second Prize, J. VIRGIN, Holsopple, Pa.

QUES. 170. A wealthy land owner has just granted me a lease to mine a lignite bed 10 feet thick and making an angle 70° with the plane of the horizon. The lease confers on me the right of way and the power to utilize any of the surface or underlying strata. The surface is on a bed of sand 20 feet thick and at first sight that would appear to be an unfavorable condition, but the lignite coal is good, and can secure an open market at a high price; we have however certain difficulties that must be overcome in the mode of working; for example, this coal is exceedingly subject to spontaneous ignition, and any small in the gob, or pillars left in, takes fire as soon as subjected to increased pressure. Therefore we must extract the *whole* of the coal, and I wish you to instruct me how to do it with the use of very little timber, at a small cost per ton, and with safety to the miners. To secure a good plan, think over all the modes of *vein* and *bed* mining in general use.

[None of our friends are even approximately right with this question, and many give evidence in their answers that they have not carefully read the question before answering it, as "any small in the gob or *pillars* left in, takes fire." Had they noticed this, they could not have given us their pillar system. Try! try!! try again. ED.]

QUES. 171. I am the principal director of a mining company, and we have the choice of one of two mine properties, and in either of which, we could work the same valuable seam of bituminous coal at a depth of 900 feet. There are two seams of coal overlying the one we wish to work and we will call the bottom one No. 3, and the one above it is No. 2, and the top one No. 1. All the seams are lying level and their depths are, No. 1, 450 feet; No. 2, 630 feet; and No. 3, 900 feet. Between Nos. 1 and 2, is a bed of coarse sandstone that sheds much water, and in one of the offered properties *A*, the top seam has been all worked out, but in the other property *B*, none of the seams have been worked. I will therefore deem it a great favor if you will say which of the properties *A* or *B* would be the safest investment, and for what reasons?

ANS. The property *A* is of very little commercial value because by working out the top seam first, the cover is broken and the natural arch over the seam 3 is therefore now a doubtful roof. Even, although the No 2 and 3 seams in *A* may be thicker than those of *B*, the latter will be the best investment, because the bottom or No. 3 seam can be worked first with safety, with a cover of 900 feet in thickness. Second, No. 2 and No. 1 can then be worked together, and No. 3 will make an excellent sump or lodgement for the water of the sand feeder.

WM. A. THOMAS,
Nanticoke, Pa.

Second Prize, JOHN FLETCHER, 428 Tonti St., La Salle, Ill.

QUES. 172. In prospecting for coal, rotary tube boring is the best, because the cores furnish fine examples of the fossils peculiar to the strata in question. This being so, will you tell me the names of some of the fossils peculiar to Permian and Silurian rocks; for example, suppose you are boring in a bed of fine shale, and the core when broken shows a featherlike fossil, made up of cells arranged in regular order, after the manner of the structures of the hydrozoa. Which formation would that shale belong to? and what is the general name of that variety of fossils? Again you are boring in a limestone, and the core when broken shows several examples of a starlike netted structure, something like a spider's web, and undoubtedly belonging to the hydrozoa, which formation is this? and what is the name of the fossil in question?

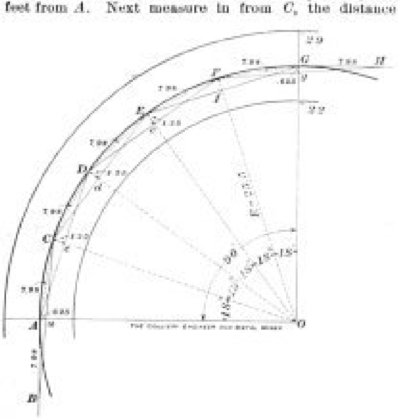
ANS. The fossil the question refers to as common in the Silurian shales, and distinguishing them by their profusion, as they are found in nearly every sample of the shale examined, is *Graptolites*, and the example of the hydrozoa that distinguishes the Permian limestone is the Aster Reticulatus.

JOS. VIRGIN,
Hollsopple, Pa.

QUES. 173. For the purpose of haulage in a level seam, a branching road has to be made, at a right angle with the main entry, and we have to make the connection with a curved entrance, the radii of which are to be 22 feet for the inside, and 29 feet for the outside of the curve. Give a plan with all the necessary explanation of how you would proceed to secure the correct curvature for this junction.

ANS.—The mean radius of the center line is $\frac{(22+29)}{2} =$ 25.5 feet.

By this method the quadrant is divided into five angles as $\frac{90°}{5} = 18°$, and therefore, taking the radius at 25.5, the versed sine is 1.25 feet, and each of the five chords are 7.98 feet. To begin, first measure in, on the radius $\frac{1.25}{2} = .625$ equal to half the versed sine, and locate this point at *a*; next lay off on the tangent from *A*, a distance equal to the chord 7.98, as *AB*. Next stretch a cord to cut *a*, and to locate the point *C*, 7.98 feet from *A*. Next measure in from *C*, the distance



equal to the versed sine = 1.25 feet to *c*, then a straight line from *A* through *c*, will with the intersecting line or chord = 7.98 feet, enable us to to locate *D*, and so on finishing as we began with the half of the versed sine $\frac{1.25}{2} = .625$ as *G g* and on to the tangent at *H*.

WILLIAM WYLIE,
Washington Pa.
Washington, Co.,

Second Prize, JOS. VIRGIN, Holsopple, Pa.

QUES. 174. My Uncle George is a mine superintendent and he asked me to-day if I had given due attention to the study of mine machinery, and steam engines and boilers? and I said oh! yes, I know all about them, and nobody can teach me any more than I know; and he said, "hem," and continued, solve me this question and let me have the answer in a few days.

We have a semi-portable hauling engine in the Burdock mine, and it is rather light for the work, and therefore, always runs with full steam. It is 80 horse power, and the highest pressure of the steam at blow-off is 90 pounds on the square inch.

The train has a speed of 10 miles an hour on the level road when the steam pressure falls to 50 pounds on the square inch, and on coming within 850 yards of the shaft the train of cars has to ascend an incline, when the speed reduces and the pressure of the steam in the boilers rises to 90 pounds on the square inch. Now the boiler fire (before the start) is banked up to keep the horse power of the boiler uniform throughout the journey.

The question makes three demands:

1st. Why does the boiler pressure vary?

2nd. What is the gradient of the incline?

3rd. What is the speed of the train on the incline?

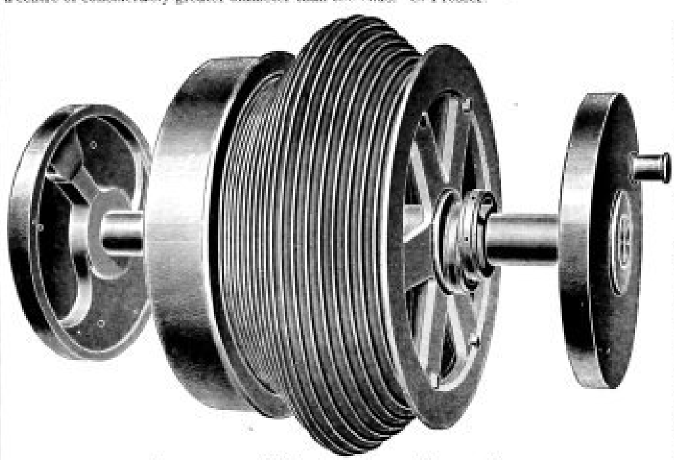
I frankly confess, I have made a mistake in bouncing to my uncle George, and I hope you will help me out of the dilemma by answering the questions for me.

[We are sorry to say this "easy" question has not been answered even approximately, thus showing that imitation is a very poor substitute for understanding. The velocity on the incline can been seen without calculation and the grade of the incline can be found nearly as easy. Our object in framing these questions is to show our friends the importance of having a complete grasp of the mechanical principles involved in the subjects of their study, and we have caught them sleeping. ED.]

The Crawford and McCrimmon Drum.

Messrs. Crawford and McCrimmon, of Brazil, Indiana show in their advertisement, in this issue, a pair of hoisting engines equipped with a double conical drum. To show the construction of this drum we present our readers with a view of it large enough to make clear the features claimed for it.

This drum resembles two similar cones placed base to base, which furnishes two ends of equal diameter and a centre of considerably greater diameter than the ends.



CRAWFORD AND MCCRIMMON DOUBLE CONICAL DRUM.

The drum is grooved from one end to the other, and the rope winds from the small diameter at one end over the large diameter in the middle and thence to the small diameter at the other end.

This plan starts the load easily and slowly and gradually increases the speed to the middle of the hoist and then gradually reduces the speed till the landing is reached.

That is, this would be the case if the engines were run at the same speed continuously. But, as the engines are always started slowly, and the speed gradually brought to a certain maximum point and held there till the load is almost at the landing, when it is gradually slowed down, it is evident that the greatest speed is secured at the proper time and the slower speed is ensured at the start and end. This principle of construction embodies the requirements for an ideal drum. Besides regulating, in a large measure, the speed of hoisting, it also makes possible the successful use of a smaller engine than would be otherwise required.

BOOK REVIEW.

THE MINERAL INDUSTRY, Its Statistics, Technology and Trade in the United States and Other Countries. Vol. III, edited by R. P. Rothwell, C. E., M. E., and published by The Scientific Publishing Co., of New York, is at hand. Price $5.00.

The two former volumes, embracing the statistics to the end of 1892 and 1893 respectively, have been previously noted in our columns. The present volume brings the subject matter down to the end of the year 1894 and is fully up to the standard of the preceding volumes.

Vol. III is a book of about 900 pages and covers the subject in a manner highly creditable to the numerous contributors and the editor. While this and the previous volumes have been subjected to severe and adverse criticism by several prominent specialists, it must be borne in mind that the work of compiling such a volume is one that few men would care to undertake, and the promptness with which it is issued materially enhances its value. While there may be room for criticising comparatively slight errors in some of the statistics, the critics should bear in mind the fact that the volume gives practically correct figures *before* the official figures are obtainable from the statistical departments of the several governments. Again, the fact that the statistics are all grouped in one convenient volume, and those interested are thereby saved much vexatious and often fruitless labor in searching for desired information, makes the work one of great value.

U. S. GEOLOGICAL SURVEY REPORTS.—No reports issued by the National Government are of more practical value than those issued by the U. S. Geological Survey, under the direction of Major J. W. Powell. We have before us in two quarto volumes the Fourteenth Annual Report covering the operations during the year ending June 30, 1893. The first volume is the Report of the Director. It is accompanied by a map of the United States, showing, graphically, the work done during the year covered by the report, as well as the total area surveyed. Vol. II of the annual reports contains in detail the reports of a number of specialists on prominent geological features of various localities, illustrated with maps, sections and views.

Monograph XXIII is a profusely illustrated and instructive volume on the geology of the Green Mountains in Massachusetts by Raphael Pumpelly, J. E. Wolff and T. Nelson Dale.

Monograph XXIV, treats of the Mollusca and Crustacea of the Miocene formations of New Jersey, by Robert Parr Whitfield of the Geological Survey of New Jersey. It is illustrated by twenty-four fine plates showing a large number of fossils.

Bulletin No. 118 is a geographic dictionary of New Jersey by Henry Gannett, Chief Topographer of the U. S. Geological Survey.

Bulletin No. 119 is entitled A Geological Reconnaissance in Northwest Wyoming, by George Homans Eldridge, Geologist.

Bulletin No. 120 treats of the Devonian System of Eastern Pennsylvania and New York, and is by Charles S. Prosser.

Bulletin No. 121 is a bibliography of North American Paleontology from 1888 to 1892, by Charles Rollin Keyes.

Bulletin No. 122 is the results of primary triangulation, by H. M. Wilson, R. U. Goode and S. S. Gannett.

We have also received through Mr. Charles D. Walcott, present Director of the U. S. Geological Survey, "The Production of Tin in the Various Parts of the World" by Charles M. Rolker, which is an extract from the Sixteenth Annual Report of the Director, Part III., and "The Stone Industry in 1894" by Wm. C. Day, which is an extract from Part IV of the Sixteenth Annual Report of the Director.

REPORT ON THE "NEW RED" OF BUCKS AND MONTGOMERY COUNTIES, PENNSYLVANIA, by Benjamin Smith Lyman. This an author's edition, and is a reprint from the Pennsylvania State Geological Summary, Final Report, Vol. III, Part II. It is illustrated with maps, sections, fossils, etc., and treats the subject in a thorough and scholarly manner.

Self-Extinguishment of Fires.

The several kinds of automatic fire sprinklers now in use in many large establishments afford familiar examples of self-extinguishment of fires. There is, however, nothing unexpected about their action; they are designed specially to put out fires, and when the sprinkler heads of fusible metal let go, and the flames underneath are deluged with water, we have simply the legitimate outcome of what was figured upon when the sprinkler system was put in. But there are a number of instances on record where the means of fire extinguishment were wholly unlooked for and of purely accidental character. One of these was furnished several years ago in a large church where a fire, caused by spontaneous ignition in a storeroom, melted the lead water pipes, and the water issuing from them quenched the flames. A similar instance happened in a tinsmith's shop. Some sheet metal pails, which had been made there, were returned by the purchasers with the complaint that they were not tight. The maker resoldered them, and, in order to test his work, filled them with water and hung them upon hooks screwed into the shop ceiling. During the noon hour, a fire heated the upper part of the room so that the handle fastening became unsoldered, and the dropping of the pails of water put out the fire. Again, in the engine room of a certain factory some oily cotton waste, left on top of a steam pump, set fire to the wooden lagging around the steam cylinders and a part of the steam-supply pipe, where it melted the soldered attachment of an automatic oiling device. The steam from this pipe escaped through the small tubes formerly leading to the oiling apparatus, and speedily extinguished the flames.—*From Cassier's Magazine for October.*

Automatic Dump Litigation.

A suit is in progress, brought by the Sullivan Machinery Company of Chicago, against the Phillips Mine Supply Company, of Pittsburg, for infringement of the Mitchell and Wilson Automatic Dump Patents owned by the former company.

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A MISTAKE IN AMERICAN COAL MINING LAWS.

PENNSYLVANIA was the first State in the Union to enact laws for the protection of life and property in coal mines. Her first laws on this subject were, naturally, crude, but they have been revised until now they are, in the main, excellent laws.

Other States, in framing mining laws, followed the example of Pennsylvania, and modelled their mining laws on hers.

Those States, which were progressive enough to realize the value of mine officials equipped with well digested theoretical as well as practical knowledge copied the Pennsylvania law in regard to certificated mine foremen and made the same mistake.

The Pennsylvania, Illinois and Alabama laws requiring the employment of certificated mine foremen are wise enactments in all particulars but one. That particular is the requirement that applicants for examination shall be citizens of, and shall have had a certain number of years practical mining experience in the particular State in which the examination is held. This restriction prevents the competent citizen of any other State securing employment as a mine foreman in either Pennsylvania, Illinois or Alabama. It also prevents a citizen of Pennsylvania securing employment as a mine foreman in Alabama or Illinois. The other coal mining States will, in time, enact similar laws, and in justice to their citizens they will place the same conditions in their laws. This will result in a great hardship to an intelligent, and valuable class of American citizens. It is, if not a violation of the letter of the Constitution of the United States, a violation of its spirit. It abridges the liberty of a citizen of the United States in plying an honest and useful vocation in any part of the nation. No other industry or profession is so handicapped.

It may be urged that a mine foreman from Pennsylvania is not familiar with the local conditions in Illinois or Alabama and *vice versa*. This reason is a weak one. If he is capable of passing a good examination, he will soon grasp the differences in the local conditions. It might as well be urged that the mine foreman from the Connellsville or Pittsburgh region would not be familiar with the local conditions existing in the mines of the Clearfield region. Or it might be still further narrowed down to the statement that the competent mine foreman in one mine would not be competent in the adjoining mine, for the local conditions are seldom the same in two mines.

Every coal mine foreman in the United States should be compelled to have a certificate of competency won by passing a thorough examination before a competent and fair board of examiners, and he should be compelled to show that he has had at least five years practical experience in coal mines, not of any one State, but in the United States.

The law should be so framed that a legal certificate of competency issued in one State should be good in another until the next succeeding examination in the district in which a foreman from the first State has secured employment. Then his worthiness for a certificate from the State in which he is working could be determined by admitting him to the examination and the acceptance of his first certificate as proof of character and practical experience in the mines. If he passes a successful examination he should be certificated. If he does not he should be removed from his position. In this way mine foremen will not be tied down to a residence for life in any one State, but like other American citizens, they will be at liberty to seek employment as mine foremen in any State they wish, or in which they think their chances for advancement are best. We do not advise that the question of practical experience in coal mines be left open to experience in foreign countries, but it should not specify experience in any one particular State of this Union.

We commend this subject to the attention of the mine inspectors and mine officials of Pennsylvania, Illinois and Alabama, and trust that they will see the wisdom of urging the amendment of the present laws on this subject.

LOSS OF GOLD IN REDUCING.

IN the processes of separating metals, ores and minerals from the particles of their associated gangue there is considerable trouble in getting the miners to know and understand that unless the crushed ore is first sized, and the slimes classified a considerable percentage of the metal will be carried off as loss in the tailings.

This statement is taken from the experience of the government of Victoria, one of the Australian Colonies of Great Britain; and to prevent the continued loss due to imperfect dressing, the government appointed Mr. Henry Rosales, M. E., F. G. S., to report on "the loss of gold in the reduction of auriferous veinstone in Victoria, and to make such recommendations as are necessary in the system of treatment, more especially relating to the dressing of slimes."

It appears Mr. Rosales has found that the Luhrig system gives satisfactory results, for the report says: "Consequent upon the continued investigations by this department, Mr. J. Cosmo Newbery visited Europe and reported favorably upon the methods of gold and ore saving known as the Luhrig system. Following upon this an inspection was made by Mr. Newbery and myself of the most advanced gold saving and treating plants on the principal gold fields, and we found that these appliances failed in all cases in one important point, namely, that no attempts were made to classify the material before concentration, and that the concentrates showed very large percentages of quartz grains, which were not only valueless in themselves, but hindered the proper working of the vanners." It was found that the loss due to the non-classification of the slimes was very considerable for "the estimate was made that the average tailings of the quartz mining districts of the colony might be considered as containing from 2 dwts. to 2½ dwts. of gold per ton, or an average annual loss at the present time, 1894, of $1,797,010 on the 898,506 tons of quartz crushed." The report next refers to improvements that have been as follows:

"The want of classification of material, to which I have time and again drawn attention as one principal cause of the loss of fine gold and mineral has been partially remedied in some cases. The Luhrig plant erected at Stawell, North German Mine at Maldon, and Long Tunnel Mine at Walhalla are object lessons of the highest value."

This report only amplifies the evidence, daily increasing, of the importance of practical miners having a better educational equipment to secure success for themselves and their employers. The merely practical man need not be jealous of the merely theoretical man, but both have good reasons to be jealous of the practical man with technical knowledge. The report next proceeds as follows: "To successfully reduce auriferous veinstone and extract the gold therefrom, *classification* should unquestionably commence from the begining of the trituration of the gangue, whether it be done by stamps, rollers, or a ball mill." Again we are told that the particles of the crushed gangue should not be smaller than the *natural* size of the particles of gold, or the grains of the contained sulphides, for it says: "To reduce the stone to a finer grade than required is a mistake that should be avoided. Elsewhere I have already uttered the same opinion, and further, I may quote an expression used by the late Sir Warrington W. Smyth, M. A., F. G. S. etc., to the effect that by crushing the stone unnecessarily fine, the gold is 'stamped dead' implying that the particles of gold would be carried off in the slimes as float gold." Altogether this report is suggestive of the steady progress that is being made in mining in every land and it is a significant fact in the whole matter that all the steps in this advance have been made with the indispensable help of technical allied with practical knowledge.

THE COOSA COAL FIELD OF ALABAMA.

THE report of Coosa Coal field of Alabama, by the State geologist Eugene Allen Smith, Ph. D., and illustrated by the sections made by his assistant Mr. A. M. Gibson, is at hand. It is a very satisfactory presentation of the facts available to the writer. But for the useful minerals obtained by mining, little would ever be known of the presence or absence of any series of rocks, in any locality, because the relative superposition is only found by such sections as we obtain by sinking and boring, and where this is not done, very little reliance can be placed on speculative opinions. This is especially so in coal bearing strata, because the existence and preservation of such a tender rock as a stratum or seam of coal is the result of it being protected from the effects of the denuding forces, by lying in the troughs or basins of crumpled and contorted strata, or sheltered in the depressions made by one, two, or more great faults.

We can therefore never determine the characteristics of a coal field until the area within the boundary lines of the outcrop has been pierced in all directions by many borings and sinkings, from which reliable sections can be made. Until, therefore, more sections of the Coosa coal-field are known, the comercial industrial, and state value of the mineral, will remain an unsolved problem, but we are happy to find that the people of the State of Alabama realize the importance of their first class resources in coking coal, iron ore, and lime, and that in the near future they will see that spending money is a good investment, when it is spent to furnish good reasons for commercial speculation.

The Coosa coal-field in its greatest length is 60 miles long. It extends 34 miles through St. Clair county and 24 miles into Shelby county where it terminates. Its breadth is nearly six miles, and it therefore has a mean area of 345 square miles. The coal is of a fine coking variety, with a small percentage of sulphur and it is therefore, adapted in a superlative degree for the manufacture of iron and steel. The seams vary in thicknes from 2.5 ft. to 4.5 ft. Like all the best varities of coking coal, the seams in the Coosa coal-field are soft and tender, and do not, therefore, command their true value when sold in the market for household fuel.

To make these seams reach their real value, the coke will have to be consumed in the smelting of Alabama ores, and in iron and steel manufacture. The field is in the shape of a long dish or basin-like trough on the south-east side of the terminus of the great Appalachian field. The report contains a number of tables of analyses of the coals of the different basins in the coal-field, but like all other tables of the kind, and we have English and Australian lying before us while we write, the solvents contained in the coal, such as nitre, common salt, sulphates of lime and magnesia, etc., are not given These solvents play an important part in the coking and combustion of the coal and should, therefore, be known and especially so when we are aware that some varieties of coal are more subject to spontaneous combustion than others.

LEGAL DECISIONS ON MINING QUESTIONS.

Reported for THE COLLIERY ENGINEER AND METAL MINER.

Insufficiency of Notice of Location of Claim.—Under the statutes, requiring a person making a location of a mining claim to file a declaratory statement thereof on oath, a statement which, on its face, appears to have been verified a year before the location of the mine, is insufficient, in the absence of proof that the affidavit was wrongly dated by mistake.

Berg v. Keogel, (Supreme Court of Montana,) 40 Pac. Rep. 605.

A Subscription by a City to the Capital Stock of a Corporation Invalid.—Chapter 114 of the Laws of 1887, entitled, "An act authorizing counties and incorporated cities of the second class to encourage the development of the coal, natural gas and other resources of their localities by subscribing to the stock of companies organized for such purposes," is unconstitutional and void. A subscription made by the city of Geneseo to the capital stock of a corporation organized for the purposes of prospecting for, developing, and operating natural gas, oil, coal, salt and other minerals, is invalid, and although bonds are issued, and accepted in payment for such capital stock, the Supreme court of Kansas holds, does not render the city a stockholder in the corporation. The city, having issued its bonds to the corporation, which it is alleged in the petition and admitted by the demurrer, are valid obligations of the city, may recover from the corporation the proceeds of such bonds illegally issued to pay the city's subscription to the capital stock of the company, and wrongfully converted by it to their own use.

City of Geneseo v. Geneseo Natural Gas, Coal, Oil, Salt & Mineral Co. 40 Pac. Rep. 655.

Valid Notice of Location.—A notice of location of a placer mining claim, which contains the name of the locators, the date of location, and a sufficient description all as required by the statute, is not invalidated by the fact that the date is preceded by the words "dated on the ground," and such words are to be regarded as mere surplusage.

Preston v. Hunter (Circuit Court of Appeals, Ninth Circuit.) 67 Fed. Rep. 996.

Right to make New Location.—A locator of a quartz mining claim, who has allowed his location to lapse and become subject to relocation, under the statutes providing for the relocation of claims on which the required annual amount of work has not been done, has the right to make a new location, covering the same ground.

Warnock v. DeWitt. (Supreme Court of Utah.) 40 Pac. Rep 205.

Sufficiency of Marking Claim.—A mining claim marked by a discovery monument, on which was placed the notice of location, and by a stake at each of three of the corners of the claim, and a monument at the center of each end line, leaving one corner of the claim unmarked, was sufficiently marked, under the statutes, providing that such a claim shall be "distinctly marked so that its boundaries can be readily traced."

Warnock v. DeWitt. (Supreme Court of Utah.) 40 Pac. Rep. 205.

Duties of the Mine Boss.—The mine boss is an individual so designated by the statute, who must be employed by the mine owner, and put in charge, with reference to its safety and its security. He has the entire supervision of the whole system of the ventilation of the mine, likewise of its entries, drifts, and rooms, and all machinery and appliances which are used in its operations. He is bound to make his reports regularly to to the mine inspector, and is subject to severe penalties for any violation of the statute. Of necessity, this would include any failure on his part in the supervision, inspection, and care which the statute requires. Miners are likewise given the right to inspect the mine and machinery, either in person or by committee, conjointly with the owner, or otherwise, as they may choose, and to take such steps as their prudence may dictate to secure their own safety and prevent accidents.

And a right of action is also given to certain designated parties in case they sustain damage by reason of any failure to comply with the provisions of the statute, or because of any violation of its requirements.

Colorado Coal & Mine Co. v. Lamb. (Court of Appeals of Colorado.) 40 Pac. Rep. 251.

Location of Mining Claim.—The act of congress provides that the locator take no more than 1,500 feet in length, nor more than 300 feet in width, on each side of the vein. This contemplates a location to be made parallel with the line of the vein, and if a locator, knowing the line and course of his vein, and willfully, and with a fraudulent purpose, locate his claim in disregard of such line and course of the vein, and establish its length, not along the vein, but across it, to an excess of several hundred feet or more beyond the 300 foot limit allowed by congress, for the fraudulent purpose of gaining and appropriating such excess surface ground as his mining claim, this would be in deliberate violation of the law, and a locator so acting could gain no rights whatever, but his location would be absolutely null and void, and he would be left in as bad a position as if one had never been attempted to be made.

Walsh v. Mueller, (Supreme Court of Montana.) 40 Pac. Rep. 292.

The Rule of Safe Place.—The doctrine that a mining company can send its employes into the bowels of the earth to conduct its mining operations without making any provision for the proper supervision and inspection of the mine for the security and protection of the miners and the mine is unsupported by authority, is opposed to sound public policy, and is cruel and inhuman. Miners do undoubtedly take upon themselves all the ordinary and usual risks of the business; but what are these ordinary risks? They are the risks incident to to the business when it is conducted by the mine owner according to the customary and approved methods and with due regard to the safety of the miners. The neglect of the mine owner to discharge his duty in this regard is not one of the risks assumed by the miner, but is a negligent act on the part of the mine owner which renders him liable in damages to any miner injured thereby. It is the duty of the mine owner to provide a competent foreman or inspector to superintend the working of the mine; it is the duty of this foreman to direct the miners when and where to work; and it is particularly his duty to make timely inspection of the timbers and walls and roof of the mine in order that no harm may come to the miners from causes which a capable and diligent inspector would discover, and when discovered, remove or cause to be removed. Where blasts are used in a mine, it is the imperative duty of the foreman to be diligent in discovering the effect of the blast upon the timbers, walls and roof of the mine, and to point out to the miners any dangerous conditions resulting from the blast, and to cause these conditions to be removed without delay, by proper appliances and with as little danger to the men as practicable. Mining is a necessary and permanent business, and must be conducted in an intelligent, orderly and systematic manner, not alone for the protection of the miners, but for the preservation of the mine itself. For these reasons, the business must have an intelligent and competent head. The necessity for this is imperative. When properly conducted, there is no pursuit in the country carried on with greater regularity, system and order, and with a stricter observance of rules intended to secure employes against accidents and property from loss or damage. The conditions confronting the miners from day to day, as a rule, are neither unexpected nor unusual. They are the common and expected incidents of mining, and when the foreman does his duty they are provided for and met without accident or any special danger. There is nothing hasty or haphazard about the business.

Finalyson v Utica Mining & Milling Co., (Circuit Court of Appeals, Eighth Circuit.) 67 Fed. Rep. 507.

Liability for Injury to Miner.—Where the superintendent of a mine, knowing that stones had been continually falling down the surface of the mine at a certain place, and that it was more dangerous than other parts of the mine, put a miner at work immediately under it without informing him of the danger, or without having the surface raked, the owner is liable for the resulting injury to such miner, who was ignorant of the danger.

De Weese v. Meramec Iron Mining Co. (Supreme Court of Missouri.) 31 S. W. Rep 110.

Duty and Liability of Mine Owner and Miner.—Under the Rev. St. section 6,871, which reads as follows: "The owner, agent, or operator of every coal mine shall keep a supply of timber constantly on hand, and shall deliver the same to the working place of the miner, and no miner shall be held responsible for accidents which may occur in mines where the provisions of this section have not been complied with by the owner, agent, or operator thereof." By another part of the same section it is made the duty of the miner "to securely prop the roof of any working place under his control," under a penalty of $50 fine or 30 days in jail or both, if he intentionally and willfully neglects or refuses to perform such duty. Under this section of the statute it is the duty of the owner, agent, or operator to keep a supply of timber constantly on hand, and to deliver the same to the working place of the miner, and it is the duty of the miner to securely prop the roof of any working place under his control. The duty of each party is clearly defined by the statue, and for a neglect of such duty by either, resulting in an injury to the person or property of the other, an action will lie. The statute makes it the duty of the agent, owner, or operator to have the timber constantly on hand, and to deliver it to the working place of the miner, and hence the miner is not concerned as to the manner in which the delivery is made. All he has to prove to make his case, as to that point, is that in fact the delivery was not made. He is not required to ask for the timber or give any notice. It is his right to have the timber delivered at his working place at all times without request on his part, and without notice to any one; and a failure on the part of the owner, agent, or operator to so deliver timber to the working place of the miner is negligence, and, if injury is thereby proximately caused to the miner, an action will lie therefor.

Coal Co. v. Estlevenard. (Supreme Court of Ohio.) 40 N. E Rep. 725.

Interpretation of Contract.—A coal dealer, entered into a contract with three coal companies, agreeing with each other as follows: The dealer agrees to represent the entire interests and sales of the other three parties in the Detroit trade; that he will confine himself to the use and handling of their coal alone, taking the same from them in equal quantities: that he will turn in all his present trade and orders, at the price of 70 cents per ton at the mines; that he will labor to improve the market, giving to said parties the advantage of whatever improvement may be made, asking no greater part of such increase than his fair proportion; and that he will keep his books, sales, and contracts open to their inspection. Said other parties agree to aid and encourage the trade of the dealer in all lawful ways. It was held, that such contract was several, and not joint, and that the parties contracting with the dealer, were bound to fill contracts made by him for future delivery, in accordance with a custom known to all the parties, at the market price of the coal at the time such contracts were made, and not at the market price at the time of actual delivery.

Shipman v. Straitsville Cent. Min. Co. 15 U. S. Sup. Court Rep. 886.

Grant of Mining Patent.—The grant of a patent to a mining claim from the United States to one who procured it for and assigned it to an alien is the judgment of a special tribunal and cannot be collaterally attacked. While it is true that the mineral lands of the government are open to location and purchase only by a citizen of the United States, or one who has declared his intention to become such, and the fact of alienage if raised at the proper time by any one adversely interested, will defeat the acquirement of title, yet the qualifications of an applicant for a patent, as well as the fact of discovery, and the compliance on his part with other requirements made essential by the act of congress to entitle him to purchase the mineral land of the government, being cognizable by the officers of the land department, when in the exercise of their jurisdiction, they approve the application, and allow an entry, the fact of citizenship, as well as all other questions of fact, is presumed to have been established, and is not open to review by the courts at the instance of third parties.

Justice Min. Co. v. Lee. (Supreme Court of Colorado.) 40 Pac. Rep. 199.

Liability for Injury to Employe in Mine.—Under the statutes, which require the operator of a coal mine to keep the same free from gas, and to have the the working places examined every morning with a safety lamp before workmen are allowed to enter, and give cause of action to a person injured for direct damage occasioned by any violation or willful failure to comply with the requirements of the statute, an employe cannot maintain an action against his employer for an injury following such violation, unless at the time he was injured he was in the exercise of due care.

Krause vs. Morgan, (Supreme Court of Ohio,) 40 N.E. Rep. 886.

Admissibility of Statements as to Dangerous Premises.—In an action for injuries to an employe caused by defects in the roof of a coal mine, statements as to the condition of the roof, made by persons not connected with the mining company are inadmissible.

Treager v. Jackson Coal & Mining Co., (Supreme Court of Indiana,) 40 N. E. Rep. 907.

Ordinary Care and Prudence.—The courts have very frequently, within the last few years, been called upon to define the meaning of "ordinary care and prudence."

New inventions in steam and electrical machinery have resulted in new occupations for men, and new mechanical appliances whereby their labor is employed, Thus, are unforseen and nice questions of the law of negligence constantly arising as the new relations of employes and employers are discussed and considered by the courts. Familiar underlying principles, evolved from generations of experience and thought, are to be applied to the peculiar phases presented by the facts and circumstances of the particular case under investigation. And so we find the opinions, in discussing the definition of "ordinary care," recognize that no fixed arbitrary rule can be laid down, but that the degree of care and vigilance required varies according to the exigencies which require attention and vigilance, conforming in amount and degree to the particular circumstances under which they are to be exercised. The care and attention necessary on an employer's part in furnishing a steam boiler is relative to the work to be done by the boiler, and the capacity of such instrument for harm as well as good. In a concentrating works, where three large boilers are needed, aggregating about 200 horse-power, it requires no technical knowledge to say that many men are necessarily employed about such machinery, and that the dangers and responsibilities of the owners and the men employed are great; hence ordinary care in furnishing suitable boilers for such works would be a much higher degree of care than, for instance, would be ordinary care in furnishing a wagon wherewith to haul the concentrates from the works to a railroad depot, or elsewhere. The Circuit Court of the United States for the Eastern district of Michigan charged a jury in relation to negligence and ordinary care as follows: "You fix the standard for reasonable, prudent and cautious men under the circumstances of the case as you find them, according to your judgment and experience of what that class of men do under these circumstances, and then test the conduct involved, and try it by that standard; and neither the judge who tries the case, nor any other person, can supply you with the criterion of judgment by any opinion he may have on that subject.

Johnson v. Boston & M. Consolidated Copper & Silver Min. Co., (Supreme Court of Montana,) 40 Pac. Rep. 298.

Liability to Accidents to Trains.—Where a rail way company delivers cars to a mining company by leaving them on a siding, it is bound to see that they are left and maintained in such a position as not to interfere with trains on the main track; and if the mining company negligently permits them to run down on the main track whereby a train is derailed and one is injured the railway company is liable.

Union Pac. Ry. Co. v. Harris. 15 U. S. Sup. Ct. Rep. 843.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

The Efficiencies of Mine Pumps.—Mr. Per Larsson recently read a paper on "Efficiencies of Some Pumping Plants on the Menominee Range," before the members of the Lake Superior Institute of Mining Engineers. This paper cannot be taken as even an approximate gauge of the efficiency of any of the classes of pumps tried, because many of the pumps or engines were either out of repair or subject to some needless resistance. For example, we are told that the main steam pipe of the Vulcan Cornish engine was too small, and as a consequence, the steam was vacillating in its flow of supply; and, says Mr. Larsson in reference to the matter: "The steam pipe leading from the boilers to the basement of the engine house is four inches in diameter and 250 feet long. This pipe is apparently too small, as shown by the sharp vacillation of the index of the steam gauge during each revolution of the engines." In reply to a question by Mr. W. J. Olcott, concerning the small result of the Worthington pump at the Aragon, compared to that of the Worthington pump at the Vulcan, Mr. Larsson said: "The pump at the Aragon has been working for four years, and the plungers are pretty well worn out, and it is a smaller pump than any of the others." Again, the quality of the coals used is an important factor in obtaining good results, and so are also the speeds and sizes of the pumps and engines. For, slow running large engines give better results, so far as economy in the consumption of coals is concerned, than small fast running engines and pumps; and in support of this conclusion Mr. W. C. Brown, during the discussion on Mr. Larsson's paper, said: "It is found in building pumping engines of that character that there is a very great increase of duty in the larger engines." This fact is exemplified in the case of the table of results given by Mr. Larsson. At Chapin a large new Cornish pump with plungers no less than 28 inches in diameter, and the engine making only 4.39 10 feet strokes per minute, the duty was no less than 63.715 000 foot pounds per 100 pounds of coal consumed. The results of two pumping plants that were tested by a mechanical engineer was sent in after the paper was read. "One plant consisted of a Cornish pump with fourteen inch poles, nine feet stroke, and geared with a single reduction of eight to one. The engine is of the Corliss type, 18″ x 60″, and is connected to a Bulkley condenser, which is supplied from the column pipe." The lift of this pump is 660 feet, the speed is 4 to 6 revolutions per minute, and the duty is 62,813,300 foot pounds per 100 pounds of coal consumed.

We cannot over-rate the value of such papers as Mr. Larsson's because the test always applies somehow; in this case we had perfection of repair, against those that were out of repair, local mistakes as in the case of the over small steam pipes, against ample provision for injection and emission. Bad coals against good ones, boilers of good types against old fashioned ones, and slow running engines, against fast running ones. Now, the results collected by the writer of the paper brought out in strong relief the peculiarities of the successes and defects of all the pumps and engines in the Menominee Range.

Perhaps one of the most remarkable tables of results sent in is that of "The New Pumping Plant of the Stirling Iron and Zinc Co., New Jersey."

It appears that after sinking a shaft through highly watered strata, the Cameron or sinking pumps were replaced by a Triple Expansion Duplex Worthington Pump, to force 800 gallons per minute against a 600 feet head. The total cost of this plant including pipes from the boilers and the preparation of the station was $10,000 and the estimated saving per day was $18.00 and the duty per 100 pounds of coal consumed was no less than the extraordinary figure of 69,502,506 foot pounds, and even this was excelled on May 3, 1895, when during a trial of 60 minutes duration the duty was 78,294,625 foot pounds.

The Mines of Elba.—Mr. Herbert Scott, a Fellow of the Geological Society of Italy, last May, read a paper on the above subject before the members of the "Iron and Steel Institute of Great Britain."

This island is deeply interesting not so much from a mining or metallurgical point of view as from its grand historical associations. It was to this small island that Napoleon was sent to govern in peace about 25,000 people, after he had tried and failed to conquer and govern the whole of Europe.

Iron mined and manufactured in this island was used as weapons at the siege of Troy, 1289 years B. C. The very name of the island, off the coast of Tuscany in the Mediterranean Sea, and consequently in ancient days accessible to the ships of Greece, is derived from a Greek word meaning "blazes of iron furnaces." Iron ore has been mined here for 40 centuries and it appears that after all the timber fuel was consumed on the island the ore was carried to the main land, where the supply of wood was inexhaustible, to be smelted.

From Mr. Scott we learn that in ancient days the processes of calcining and smelting were about the same as that practised by the Chinese and the natives of Hindustan, living on the slopes of the Himalaya Mountains now, that is, the furnace consisted of a rude hearth divided into pockets or cells, and in one the ore was roasted, and in the other the ore was smelted, and in another the front of the bottom of the pocket was open to the air, and in it logs of wood were kept burning with a fierceness proportionate to the speed of the wind blowing over the tops of the mountains, for the furnace was always set at a high elevation on the mountain slope.

In the ancient days, as the result of not understanding how to construct a reverberatory furnace with a chimney flue, the waste of fuel was enormous, for to make a ton of iron bloom, it required 9 tons of wood for fuel.

The ancients did not use the iron as castings, and therefore made it at once into true steel, or a kind of steely iron, and strange to say the ancient steel was more of the character of the latest steel, known as Siemen's or Bessemer. During the process of smelting cast iron is produced and contains a high percentage of carbon, to convert this into malleable iron the carbon must be burnt out as in the modern process of puddling, but the ancients burnt it out, by adding some calcined ore, the oxygen of which effected the purpose required, and they found that when different quantities of the ore were added to the metal in the furnace, they obtain malleable iron, or mild or hard steel according to the weight added, the result was with good ore they were able to produce the finest examples of steel, as the celebrated Damascus steel. The ancients did not used a flux for smelting their iron ores, the result was a high percentage of the metal combined with the silica of the ore to produce slag, or we may say they fluxed the iron ore with oxide of iron instead of oxide of calcium, or lime, and we find according to Mr. Scott, the slags contain no less than 60 per cent. of ferrous oxide and 12 per cent. of ferric oxide.

Through all the 40 centuries the mining of the ore has been most primitive, the deposits having only a relatively thin covering of earth, all that has been required and is now required, is to remove the overburden and mine the ore in the open.

Coal in Illinois.—The thirteenth annual report of the Illinois State Bureau of Labor Statistics is at hand, and contains valuable tables of numerical facts of great importance to all concerned in the commercial prosperity of the country, and to all who are anxious to promote the safety and happiness of their fellow creatures engaged in the hazardous pursuit of mining.

Every report contains the records of a cycle in human experience, for men continue to repeat their follies and mistakes and receive the rewards they do not want. The cycle of the year 1894 is remarkable for a triad of misadventures, namely, a strike, a depression in trade, and an alarming increase in the number of fatal and non-fatal accidents in the mines of the state.

The results of the strike were: First, an average loss of 70 days' employment by the miners, and a present and future loss of trade by the operators, a loss in the wealth of the state, and in a lesser, yet sure degree, an injury to the wealth and resources of the nation; second, after the strike a larger number of men were employed, and many of them not being practical miners, their inexperience was the cause of much of the increase in the number of fatal and non-fatal accidents that the Bureau records, and yet, notwithstanding all this, the miners of the United States have won the palm of victory for their hard-working industry, for the yearly output in tons of coals produced per man is greater than in any of the other coal-fields of the world, and we will show the proportions for the miners of six nations taking the miners of the United States as unity of tons of coals produced. The results are calculated from the tables given by the Bureau in their report, and the tables in question were copied from the tables of "The World's Production of Coal," published by the British Government.

Actual output of coals per person employed in the mines of six great nations. Year 1892.

United States	468
Great Britain	281
Germany	237
France	197
Belgium	165
Austria	179

Proportionate output of coals per person employed in the coal fields of six great nations. Year 1892.

United States	1.000
Great Britain	.600
Germany	.507
France	.419
Belgium	.352
Austria	.382

Lake Superior Mining Institute. Address by the President, Mr. J. Park Channing.—It has seldom been our pleasure to read an address that was so suggestive of wise steps that ought to be taken to reduce and alleviate the suffering arising from mine accidents. The speech evidently was not made at short notice for a special occasion, for every paragraph indicates close, interested, sympathetic and prolonged observation in mastering all the important phases of the subject. Mr. Channing inspires confidence in his conclusions by first applying the gauge to himself that he uses in the measurement of others, and here is what he says:

"As Sir William Temple has said, 'The abilities of a man must fall short on one side or the other like a scanty blanket when you are abed, if you pull it upon your shoulders your feet are left bare; if you thrust it down to your feet, your shoulders are uncovered.'"

In one short paragraph he finds a place for the phase of mining experience on which he treats, and here it is.

"In selecting a subject for an address to the Institute, I have determined for the time to neglect the strictly economical side of mining and to call your attention to the ethical. Mining, like all other problems, is in the nature of a polyhedron; we must examine all the faces and angles to fully appreciate the crystal."

He commences his reference to mine accidents by confronting us with the awful, and oft repeated truth, namely, that many of the sorrows of humanity are self inflicted, and thus the president speaks.

"A large proportion of humanity will not take care of itself, will not follow the common laws of health or nature. I regret to say we must use force to compel them. Only a few days ago the press noted the closing down of a factory in the South where flints are ground, because of the enormous death rate among its employes due to inhaling dust. Masks and respirators were provided and yet the men persistently neglected to wear them."

He continues his remarks, however, and not with lamentation, but with a noble declaration of duty, for he says:

"While the natural carelessness of mankind is difficult to overcome, it does not excuse us who know better from continually exerting our influence for right."

Mr. Channing does not, in a cowardly spirit, heap reproach on the every day miner, but finds more to say about the want of oversight manifested by the mine inspectors or guardians for the execution of the law, and here is one, out of several given from the records of the State of Michigan.

"In Iron county, a careful examination of the records at Crystal Falls, shows a report, setting forth the death of nine men, but failing to give the year. Also a report for 1893, showing the death of two men, and a special report for 1893 on the Mansfield cave-in fail to record any fatal accidents.

"None of the reports except the last, give any statistics, and so the whole county has has been omitted in compiling tables.

"The reports for 1888 in Marquette county could not be found." Mr. Channing then gives the Prussian and British methods of classifying accidents in mines, and shows that they are worthy examples on which to base a classification of our own.

In short then, the President's address is so comprehensive in dealing with the laws that are required, and the steps that ought to be taken to enforce the execution of the laws, and the ethical principles, that should ensure respect for the laws, that we hope it will bear the fruit that has been nourished by a wise well meaning man.

The Lake Mine Hoisting Machinery, Cleveland Iron Company, Ishpeming, Michigan.—The engines for this hoisting plant, are of the cross-compound, condensing, steam-jacket type, with Corliss valves and an independent Deane condenser. This hoisting plant was made by the M. C. Bullock Manufacturing Co., Chicago.

The compounding cylinders are 20″ and 32″ in diameter, and have a 48″ stroke, and are constructed for a steam pressure of 125 pounds. The hoisting drums are so connected that changes in the length of rope for different depths can be adjusted with ease, expedition, and accuracy.

One drum we will call *A* is keyed or fastened onto the engine shaft, while the drum *B* when out of clutch is loose on the same shaft, and to enable the alteration in the lengths of the ropes to be made, the brake is caused to seize on *B* and hold it stationary and fast while the engine winds rope on or off the drum *A* for the necessary adjustment.

For hoisting, the drums *A* and *B* are bolted together by a quick connection, that takes the character of a fast clutch and secures both the drums and the engines under the control of the one brake on *B*.

The posing of the valves for reversing the engines, is done by turning through a portion of a revolution the shaft that synchronizes the valve movements, and this is done by a nut or helix that is pressed along the axis of the shaft by two steam cylinders that are provided for that purpose.

What is called an intercepting valve, is really a replenisher valve to restore a supply of steam to the low pressure cylinder, when the receiver from the high pressed cylinder is exhausted. The drums are 12 feet in diameter and the tread surface for the rope on each is 3.5 feet wide, making the tread surface of each drum sufficient for a rope 1¼ inches in diameter and 1256 feet in length. The following particulars are deeply interesting and worth careful thought: "The governor speed is thirty-five revolutions per minute, giving about 1320 feet of rope travel per minute.

No gates are used in the shaft.

The angle of the shaft is 50°.

The skip load is 3½ tons.

From the dump to 1st level is 310 feet.

From the dump to the 2nd level is 440 feet.

From the dump to the 3rd level is 570 feet.

Hoisting has been done from the 2nd and 3rd levels at the rate of twenty-six skips in twenty-five minutes.

With a pressure of 100 lbs. the following are the current results, but the engines are made for 125 pounds pressure. Total H. P. 263.58 with a credit to the condenser of 21 per cent.

These facts have been taken from a paper by Mr. J. M. Bickers, read before the members of The Lake Superior Mining Institute.

Open Pit Mining in the Mesabi Range.—A paper on the above subject was read by Mr F. W. Denton, before the last meeting of The Lake Superior Mining Institute. Mr. Denton's paper deals directly with a deposit of iron ore in the Mesabi Range, that lies under the cover of a small overburden, and here is his introduction of the subject.

"With the discovery on the Mesabi Range of large, more or less flattened masses of iron ore, with in many cases a shallow covering, interesting problems in mining have arisen, such as, how deep will it pay to strip? and after this is done, how shall the ore be mined?"

He shows there are two methods of mining ores with a small overburden, one is to strip a large area, and blast the ore, and fill it in the open; the other is to remove a limited portion of the overburden, and where the bed is of considerable thickness, to undercut it with levels and connect the surface and the levels with raises so that after the ore is blasted, it can be filled by the raises into the cars in the levels and then sent on to the shaft bottom to be hoisted. He discusses the advantages and disadvantages of the use of the steam shovel for lifting the ore and delivering it into the cars, and concludes that this device is not economical except when the work advances upgrade and the drainage takes place by gravitation and is therefore inexpensive, for he says: "It would seem, however, that the use of steam shovels has not the extended application of the milling system, but will be limited to the favorable conditions, such as easy grades of approach and easy drainage. The ideal conditions for steam shovel work would occur should the ore lie in a side hill and dip in the same direction as the hill, with its lowest point at or above the level of the adjoining country. Such occurrences of the ore unfortunately are rare. The steam shovel from a mechanical standpoint is a very uneconomical machine, and costs of repairs are high.

"Locomotive expenses are increased rapidly by adverse grade, for a locomotive can haul on a two per cent. grade only about one-eighth, and on a three per cent. grade only about one-twelfth of what it can haul on a level. The economy of steam shovel mining depends on keeping the shovel constantly at work, in order to maintain a large output. In the milling systems the work grows in depth, and after a given amount of stripping has been done, all of the ore uncovered may be removed before further stripping is necessary.

"When the block of ore has been mined, the pit thus may be used as a place of deposit for the next stripping. It ought to be possible to utilize this advantage to materially reduce the cost of subsequent stripping, for the haulage would be short, and by systematic methods, the bottom of the stripping could be dumped into the bottom of the pit, and gravity would thus be made to assist throughout the work."

The paper is an excellent one for reference and here are among many other valuable facts the advantages and disadvantages of the systems.

Comparison of Open-Pit with Underground Mining.

"1. There is less danger to the workman from falls of roof and blasting, and the chances of fire are less.

"2. Economy in mining due to the possibility of using large stopes and large blasts, and thus avoiding the narrow working places necessary in underground mining—an advantage which increases with the hardness of the ore. The easier and better superintendence: The saving of the cost of timbering: The saving of the cost of tramming: The small saving in the cost of lighting.

"3. All the ore can be mined with equal ease and absolute certainty, thus avoiding the loss of ore more or less great, which must always accompany underground work.

"4. Saving of the expense of making stock-piles and subsequent loading.

"5. As the output per man per day is increased anywhere from two to nine times, the increase in cost due to an increase in wages will be less.

"6. If the ore requires sorting it can be done cheaper and better in daylight. Or, if thorough mixing is desired it can be done better in open pit mining.

Chief Disadvantages of the Open-Pit Method.

"1. The necessity of providing a place for the waste material removed. This has been a chief source of difficulty elsewhere, and no doubt will often be so on the Mesabi.

"2. If masses of glacial drift; beds of sand, or quantities of unsaleable ore are met with they must be handled. In underground work these deads could be left in place, or at least would not have to be handled.

"3. The expenses of open-pit work increase rapidly with the depth of covering, while those accompanying underground work are independent of this depth, at least up to the point when stripping is no longer a possibility."

Korumburra Coal Fields, Victoria, Australia — *Intrusions of Volcanic Dykes.* In a government report of the coal fields of Victoria, we find that: "During a preliminary examination of the sections of a portion of a field visible in railway cuttings between Nyora and Korumburra, it was observed, that the sandstones, shales, and subordinate coal seams had been much disturbed by the intrusion of volcanic dykes. It was therefore with a view to prevent unnecessary expenditure in boring in disturbed and faulted strata that the area to the west of Korumburra was first surveyed.

A Singular Excavator for Coal.—"I have before," says Mr. James Stirling from whose report we quote, "drawn attention to certain organic agencies in the formation of soils, and special reference was made to the work performed by the land crab in bringing up pieces of the rock forming the sub-soil, and suggested that these diminutive excavators might prove useful in assisting the miner in finding coal seams in South Gippsland and Mr. Bellamy informs me that one of the young men working with him, has successfully utilized the hint, and by carefully observing the material brought up, and forming a small heap round the orifice made by the crab, he detected small pieces of coal and sank a shaft on the spot, and cut the coal seam 4 feet below the surface.

Origin of the Coal Seams.—"The coal deposits found in the Korumburra and Jumbunna coal fields are of Oolitic age and the coal is good, but there are only about three 3 feet seams that will probably yield 35,755,511 tons of coals, but the two things that are remarkable about these measures are, first, *coal* was not expected in Victoria, as the true carboniferous measures are absent, and, second, the origin of the seams appear doubtful according to the claims of the accepted theory that: "The coal seams consist of mineralized vegetation *in situ*." The result is Mr. Stirling thinks that the vegetation from which the seams are derived has been carried onto the sites of the beds by floods, for the coal seams consist of different varieties of coal more or less laminated with stony matter, and there is found in many cases within the pieces of coal, glassy like rounded pebbles, and Mr. Stirling thinks that all this is indicative of conditions that could not exist in the deposition of coals of uniform quality, and nearly uniform thickness. Here are Mr. Stirling's conclusions.

"The explanation offered by many eminent authorities that coal beds are formed by the growth and decay of plants which flourished *in situ* in marshes does not account for all the different conditions observed in studying the carboniferous deposits in South Gippsland, and the following facts present themselves to my mind as difficulties in accepting an otherwise plausible theory:—

"First. Although small bands occur in some of the beds, and underneath the seams as at Outtrim and furnishing an excellent holing,—yet there is nothing to show that such bands represent old soils in which the plants forming the vegetation of the coal beds grew.

"There is an absence of true 'seatstone' containing imprints of the rootlets of plants, such as the stigmaria, associated with the underclays of the true carboniferous beds elsewhere.

"Second. On the contrary, there is strong evidence that the vegetation has been transported from the localities in which it flourished.

"Third. Among other instances, I may refer to the existence of finely water-worn pebbles of glassy quartz in coal of the Korumburra mines, and also the occurrence of occasional lenticular-shaped deposits of clod or shaly matter associated with some of the seams.

"Fourth. The difference in the physical structure of the coal in the same bed, one portion consisting of a mass of charred material resembling an accumulation of charcoal, while another has alternating bright and dull bands or layers, one of which is highly bituminous and the other earthy."

"Fifth. The remarkable variation in the thickness of some of the seams, the false bedded nature of the strata above and below them, and the occurance of portions of the trunks, branches, and roots of trees, regularly deposited in the sandstone beds, all point to driftal agencies in the accumulation of the vegetation forming the coal seams."

Mr. Stirling does not allow or indorse the accepted theory, that the coal seams consist of the mineralized vegetatation that grew where the seams are found, but claims that the driftal theory alone can account for the existence of these coal deposits. The report however claims no finality in the matter, but furnishes facts that are also favorable to the *in situ* theory, and we find abundant evidence that the region of these coal fields was during the deposition of the seams and the immediately overlying and underlying strata subject to great storms and floods that washed off portions of the bog and washed in the roots, branches and trunks of trees already referred to, and in the action of moving water, we have sufficient to account for all the apparent divergence from the common origin of coal seams. The following is Mr. Stirling's statement of these facts:

"Referring to the genus Baleria and to the scarcity of coniferous plants, while there is a great abundance of ferns, cycads, and equisetacea, it is remarked that those plants grew near the shores of the lakes and in islands in them, and thus their remains were more readily preserved in the sediment accumulating in the still shallow waters. Whenever the strata was of such a character as to indicate the presence of water in motion, such as rivers or floods from the highlands, then we do find abundant traces of coniferous vegetation.

"Thus in the sandstones of the lower series we find coniferous wood usually silicified, but it is especially in the upper series—or that characterized by the large amount of granite sand that we find the greatest number of coniferous relics. Often isolated trees which must have been a foot or more in diameter, occur embedded in the sandstones and shales of the upper measures, but which are now flattened by pressure."

In conclusion it is interesting to know, and to notice, that the coal fields of Australia like those of India are not of the Carboniferous, but of the Triassic and Jurassic periods.

Mine Locomotives with Secondary Batteries B. F. Cambessedes in American Manufacturer.—At Amercœur, near Charleroi, in Belgium, electric traction has been applied in a gallery joining two pits, 1575 meters apart, in which, to avoid the cost of overhead conductors the principle of driving by secondary batteries carried on the locomotive is adopted. The gauge of the line, which is laid with fish-jointed flange rails weighing 12 kilograms per metre, is 500 millimetres, the minimum radius of curvature is 8 metres, and the average gradient (in favor of the load) 1 in 370. The first locomotive, built in 1893, resembles a low-sided goods-wagon, having a rectangular body 2.725 metres long and 1.2 metre broad, carried on two axles 1.1 metre apart, the length being further increased by a platform for driver and brakesman at either end to a total of 3.969 metres. The secondary batteries, on Julien's system, include 36 elements, each containing 12,300 by 200-millimetre lead plates, with an active weight of 31 out of a total of 40 kilograms. These are arranged in four groups of nine in covered ebonite boxes, two being placed at either end, leaving a space of 525 millimetres long in the centre for the motor. The boxes are connected by naked copper wire, and the main conductors to the motor are in tinned-copper, insulated with vulcanized rubber; their section is 28 square millimetres allowing the passage of a current of 100 amperes without being unduly heated. The total capacity of the battery is estimated at 465 ampere hours, or 15 ampere hours per kilogram of plate employed.

The motor is of the Lahmeyer type, with bipolar field-magnets of cast iron, series-wound, and Siemens' drum-armature, the core being built up of alternating thin disks of charcoal iron and vegetable parchment. The brushes of carbon, electro-coppered, maintain a fixed position on the commutator independent of the direction of rotation of the armature; and as the breadth of the pole pieces is limited to about half the circumference of the latter, a neutral zone is obtained of sufficient breadth to prevent danger from sparking. The armature makes 1020 revolutions per minute, which is reduced by two changes to 85 on the driving axle, the latter receiving motion from an intermediate blind axle by means of pitch chains. The wheels are 500 millimetres in diameter, giving a traveling speed about 2.4 metres per second, or 8 kilometres per hour.

The total weight of the locomotive is 3,200 kilograms, and that of the train drawn 9 750 kilograms, made up of 15 trams of 250 kilograms, each carrying a load of 400 kilograms of coal, giving, with the engine, a total load of 12,950 kilograms. The journey of 1,575 metres is performed in 11 minutes, giving a useful effect of about 150 kilogram-metres (two horse-power).

The mean potential at the terminals of the motor being 70 volts and the current 30 amperes, the energy consumed is 2,100 watts, or 214 kilogram-metres, giving an efficiency of 70 per cent. According to the calculation of the author, the disposable energy of the battery may be taken at 45.5 horse-power hour, to be expended during eight working hours in the shaft, equal to 5.7 horse-power gross exerted continuously, or 4 horse-power allowing 70 per cent. efficiency for the motor and transmission. This, however, is subject to some reduction, as it is necessary not to leave the batteries completely uncharged at the end of the day's work. What effect is realized from the batteries has not been determined, but experiments made with one of the same type under other circumstances showed, for 20 consecutive operations, charging and discharging, an average of 78.7 and maximum of 85 per cent. Allowing 80 per cent. and the same figure for the primary dynamo, the mechanical effect realized becomes .80 × .80 × .70 = 45 per cent of that of the driving engine at the surface. This is subject to a further deduction by the loss due to resistance in the cables connecting the dynamo with the charging station, which does not appear to have been determined experimentally, but is computed by the author to be equal to about 4.2 per cent., as the depth of the gallery below the surface is only 28 metres, and the length of conductor in the complete circuit not more than 150 metres. In a deep pit, say 500 metres, requiring about 1,100 metres of cables, this loss would be very much larger, and might amount to 25 per cent. of the energy of the primary dynamo. In the present case we obtain as a final result that 40 per cent. of the power expended at the surface is reproduced in the driving wheels of the locomotive, or about twice as much as can be obtained with compressed air, which rarely gives more than 20 per cent., except special means are adopted for supplying heat to the air during expansion.

The daily working cost of the locomotive is given as follows:

Driver's wages	$ .80
Motive power and charging cost, etc	.51
Maintenance of accumulators	1.00
Sinking fund and interest on capital	.59
Total	$ 2.80

This, upon the work done—300 tubs, with a net load of 120 tons, hauled 1,575 metres—corresponds to a cost of 7.4 centimes per kilometre (about 1.2d. per ton-mile), or rather less than half that of horse-traction, which is 16 centimes. In this estimate the duration of the positive plates of the accumulators is taken at a minimum of six months, but in actual work they have been found to be in perfectly good working order at the end of that time.

The locomotive described above has subsequently been supplemented by another of greater power, and differing in construction in several particulars, the most important of these being the substitution of two four-wheeled bogie for the two rigid axles of the first one, and the division of the power, each pair of axles having its own motor, with transmission by epicycloidal spur-gearing instead of a combination of spur and chain-gearing driven by a motor common to both.

The Prevention of Explosions in Mines.—The following is from the *Colliery Guardian*, and is a summary of a report that was recently published in the Austrian *Mining Journal*.

As the majority of colliery explosions are due either to blasting or to defective lamps, attention is naturally directed chiefly to these two points. The danger of an explosion being caused exists at the very moment a shot is fired. Despite the number and variety of the methods of detonation that have been proposed of late years, there is in Austria a marked tendency to return to the electric method and to use no other in fiery mines. The employment of the ordinary fuse, an appliance which on account of its cheapness is still largely used, is not unattended by danger. The dangers were well shown in some experiments made in the Ostrau Collieries, the fuse, being found to explode gas mixtures containing only 1½ per cent. of firedamp. At several collieries in the Ostrau-Karwin district, the use of this fuse is only permitted under certain conditions, whilst at others its use is absolutely forbidden. Some collieries that still use it employ only the gutta-perch pattern, as sparks are not so frequent. The Lauer friction igniter, an Austrian invention dating back to 1887, is now employed only to a limited extent in the Ostrau coalfield. At first its use led to numerous accidents caused by careless handling in transport, by tamping too vigorously, and by the wires becoming entangled. This instrument possessed, however, the advantages that when an accident did happen, as a rule only the person suffered to whose faulty manipulation the accident was due, and that no serious firedamp or dust explosion resulted. A more recent invention, the Tirmann percussion igniter, has not as yet come into any general use, although it has been tried in a number of collieries. It is quite as cheap as the Lauer igniter and it is easily handled. The number of of miss-fires is, however, considerable, and experiments prove that this is due to the want of strength in the spring which projects the bolt against the explosive. The electric method, which appears to be the surest, has hitherto been employed almost exclusively in shaft-sinking and in driving stone-drifts. It is now, however, coming into use for other purposes. Laying long lines of conductors in the workings is, however, a matter of difficulty; the method is uncertain in its action in wet places; and the work of a miner carrying some 20 lb. weight of electric firing apparatus is rendered difficult in steep workings. The danger of the ignition of firedamp in the colliery from sparks at the detonating machine and between badly-covered conductors is considerable.

The machine itself must be carefully attended to, and the insulation of conductors should be as nearly perfect as possible. Wherever practicable the wires should be placed on opposite sides of the roadway. At one of the collieries in the Ostrau district, it may be noted, an electric firing plant has been imported from England.

The current in this is so well regulated that the spark produced does not explode firedamp. One objection to the electric method is that when several shots are fired together, the various explosions are so nearly simultaneous that only one report is audible, and miss-fires consequently often pass unnoticed.

Adverting to the precautions taken in the Austrian collieries during shot-firing, Mr. Lamprecht refers especially to the employment of a special class of workmen to fire shots. Before firing the shots these men carefully examine the workings for gas. This practice is now general in Austria. Shot-firing is often very carelessly carried out, and it is quite out of the question to entrust the average coal-getter with a delicate instrument for gas testing.

Turning to explosives, it may be noticed that in Austria ordinary black powder is rarely used in mines that are at all fiery. Compressed black powder is frequently used. Although it is cheaper than ordinary powder and easier to handle, it is even more dangerous than black powder in the presence of gas. Dynamite is very largely used in the Austrian and Hungarian fiery mines, and the water cartridge, which is used only in rare instances, provides a certain method of obviating explosions. Of the explosives in which salts, containing water of crystallization, are added with a view to reduce the temperature of the gases produced on explosion by this water being converted into steam, soda flameless dynamite has found the most extended use in the Ostrau-Karwin district. Its deliquescence is, however, a great drawback. The use of explosives containing ammonium nitrate is attended by great safety in fiery mines. All the high explosives have, however, the disagreeable property of deflagrating instead of exploding. To this cause several of the most notable accidents of recent years must be ascribed. Lime cartridges were found quite unsuitable in the Austrian mines, and the methods of wedging down the coal advocated at various times have been found unable to compete with blasting powder.

Turning now to the methods in vogue for lighting the workings, it is found that in the Austrian and Hungarian collieries the Wolf benzene lamp is mostly preferred. It is undoubtedly a good gas-tester, and the device that enables the lamp to be relit without opening it presents many advantages. In the Ostrau pits the average velocity of the air-current is from 13 ft. to 16 ft. per second and the Wolf lamp is safe for such a velocity as that. The magnetic lock is not absolutely faultless, as after a lamp has been in use for some time unscrupulous miners easily find means of forcing it open without damaging it. The extent to which the recklessness in some miners may go is well shown by the fact that the period from October 29, 1894, when a serious colliery accident occurred at Anina, to November 20, in that district where 3,000 miners are at work, no less than three cases of unauthorized opening of Wolf benzene lamps were detected; in two of these the magnetic lock was uninjured. By swinging their lamps with both hands violently against the ground, the Roumanian miners in the Banat collieries succeed in forcing the benzene out on to the ground so as to light their cigarettes. The Mueseler lamp has been used for several years in the collieries of the Rossitz district and no accident has been traced to it. The Pieler lamp was largely used for gas testing, but in most of the Banat collieries its use has been discontinued.

Although stationary electric lights have been successfully introduced in the Austrian collieries, no portable electric lamp has yet been found to replace the safety lamp. The chief objection to such lamps is that they afforded no indication of the character of the surrounding atmosphere, and further that the length of time during which the light will last is uncertain. One of the best is the Bristol lamp, which is now used in the Karwin collieries in dangerous places.

Auriferous Deposits of New Zealand.—From a paper by Mr. Henry A. Gordon of Wellington, N. Z., and read before the members of The American Institute of Mining Engineers, the following extracts are taken:

In the Upper Taieri district, "wire gold" is occasionally met with in considerable quantities. It is always obtained at or near the surface, and was in the early days of the diggings considered by many of the miners to be petrified grass-roots. This form of gold is now less frequently met with; but in 1881 McKay, the mining geologist, saw a parcel of 40 oz. of gold of this character at Naseby, and purchased a few pennyweights of it, comprising most remarkable pieces, from the bank where it was sold. There were thin wires of gold straight or bent, one side of which was smooth or striated, the other side being covered with small cubical crystals of gold. This sample, or part of it, was taken to Sydney and exhibited at the first meeting of the Australian Association for the Advancement of Science. Last year Mr. McKay saw, in the possession of Mr. John McKersle, a fine specimen of the same character of gold, which was obtained somewhere in the neighborhood of the Carrick range. It was about 1½ in. in length and about 2 in. in diameter, and, like the specimens already mentioned, smooth on one side and covered with crystals on the other. Such gold might possibly be derived from the denudation of lodes, but the probabilities are against this view. It is to be noted that the samples hitherto found came from districts where the quartz drift deposits of cretaceo-tertiary age are auriferous, and as the strata are tilted to considerable angles, gold-bearing bands are thus exposed at the surface, where a partial solution of the gold might be again precipitated by organic matter and crystallized at the outcrops. Another possible instance of gold precipitated from solution is reported in the Macrewhenua field, but the occurrence requires verification. Last year Mr. McKay thought he detected minute crystals of gold which were supposed to be derived from a greensand band on that field. Samples of the greensand subsequently sent to Wellington yielded no gold, but the formation was declared by the miners to be gold-bearing. The greensand is a marine deposit, full of sharks' teeth and shells of various mollusks, and consists of glauconite and very fine quartz sand, that has evidently been deposited in comparatively deep and still water, and is therefore very unlikely to contain mechanical gold, however fine.

The underlying quartz drift has auriferous layers or bands through it, and extends over a very large area of Otago. Sloping as it does from higher to lower ground, as on the flanks of the Kakanui range, it would at the lower levels become saturated with water, possibly chlorinated water, which would dissolve a part of the gold in the lower drift, and, under pressure, would rise into and saturate the greensand band, while the organic matter in this band would be sufficient to effect the precipitation of the gold now present in the greensands.

Mechanical Deposits.—Recent and pleistocene gold deposits need not be adverted to in this paper, and, as many of the later pliocene gravel deposits are not readily distinguishable from those of still younger date, the most modern deposits that will be mentioned here are probably of older pliocene date.

Pliocene and Upper Miocene Deposits of the West Coast of the South Island.—The youngest of these are the gravels of the Humphrey's Gully range, on the southern side of the Arahura Valley. Similar gravels are noticeable at O'Donohue's Creek, five miles from Kumara, on the Kumara-Christchurch road. At the latter locality, though gold is present, and the bed of the creek has been worked, the gravels indicated have not as yet proved profitable. At Humphrey's Gully goldmining has been carried on in these gravels for a long series of years, and there is yet an unlimited supply of material to be operated upon. Auriferous gravels—it may be of a slightly greater age—are worked in the Totara district on the top of Mount Greenland, 3,000 ft. above the level of the sea; nearer the sea level in the Mount D'Or claim, near Ross, and in other claims in and along the eastern margin of Ross flat; while on Ross flat the same gravels are found 240 ft. below sea-level and contain large deposits of gold. The same beds have a very large development in the northwestern part of Westland, but, owing to the small percentage of gold yielded, they are not worked at the present time. They also have a large development along the east side of the Grey Valley, more especially in the valley of the Little Grey; and at the source of this stream they fill the valley between the Paparoa range and the hilly country to the southeast of Reefton. In the Inangahua Valley they have an important development between the north branch of the Inangahua River and Boatman's and Larry's Creeks; in the southwest part of the upper Buller Valley their distribution has been less definitely ascertained; but between the junction of the Owen and the outlets of Lakes Rotoroa and Rotoiti, north of the Devil's Grip, an enormous development of these gravels fills the northern slope, between the mountains to the east and west, to the shores of Blind Bay. The same gravels are largely developed along the east coast of the South Island, but neither in the Marlborough nor in the Canterbury district are they known to be gold-bearing. In the interior district of Otago they have again a large development, and are mined for gold at the Kyeburn, on the eastern side of the Maniototo Plain. They are largely developed in Ida Valley and in the Manuherikia Valley, and appear at several places in the Molyneux Valley below the junction of the Manuherikia River.

Meteorology and Mining.—"Meteorology and Mining" was the subject of a paper descriptive of a method of indicating meteorological conditions and changes in and about coal mines, which was read before the members of the South Wales Colliery Officials' Association, at Pontypridd, on Sept. 14th, by Mr. Joseph Thompson, M. E., of Cardiff. Mr. Thompson said there could be no question of the absolute unanimity of feeling that it was desirable that explosions of gas in coal mines should, if possible, be prevented, and the contingent loss of life, and destruction of property which occasionally occurred, be avoided. The axiom "Remove the cause and the effect will cease," was as true to-day as ever, and as applicable theoretically to the problem of how colliery explosions were caused as it was to any of the simpler problems of life. The ability to pass a quarter of a million cubic feet of air per minute through a main airway was one thing, but the advisability of doing it was another, for if it be possible for the seat of a explosion to be in the main intake airway where most of the air passes with the velocity of a gale, such velocity must necessarily preclude the possibility of searching with the safety lamp to ascertain the presence or otherwise of fire-damp. Making a passing reference to the coaldust theory, the speaker thought no one would venture to deny that these hurricane velocities were responsible for such large quantities of the dust being carried through long distances in suspension in the air-current, and deposited in considerable bulk at points where such might not otherwise have occurred. Further, it was clear that in the event of an explosion originating in such a current, impregnated with this inflammable dust, the tendency must be with such a high velocity to elongate the flame of the explosion, and thus not only most seriously increase the capacity for damage and destruction by burning, but intensify the violence of the explosion itself. The speaker then gave an interesting description of an instrument which he submitted to the meeting. It had been called a meteorograph, or a delineator of the atmosphere, and was intended to be hung against the wall; and when fixed up to represent any set of conditions or circumstances. It presented the account in bold text, and in popular phraseology, and entirely free from the ambiguous confusion of technical terms. In its scope for coal mining purposes it embraced the elements of pressure, temperature, moisture, and time of observation, together with a diagnosis stating whether the indications given by the diagram were "more," or "less," or "similarly" favorable (or unfavorable) as compared with what was indicated twenty-four hours previously, so that there should be little, if any, difficulty on the part of those using the apparatus keeping in constant touch with the operations of those physical laws and forces which admittedly exercised so powerful an influence for good or evil upon the manœuvres alike of exudations and accumulations of fire-damp in coal mines. Structurally, the apparatus was self-contained—when fixed it had no loose parts to become mislaid or lost. Dealing with pressure (barometer) he had made an entirely new departure by dividing the barometer scale into zones of high and low pressure.

He was as conscious as anyone could be of the seemingly inexplicable mystery which usually surrounded the problem, after an explosion, of how it was caused; but, so far from regarding it as one of the hidden things of nature, or accountable for only by some outside circumstance or combination of circumstances into which only experts might pry—circumstances such as are sometimes set up in connection with blown-out shots, coaldust, and such-like theories—he ventured the opinion which he had held and continued to strongly hold that, if fire-damp were prevented from coming into contact with open flame, there would be few or no explosions. He might go further, and say that it was not the gas we know of in the mine which gave rise to difficulty and danger, but that which we do not know of, which coroners' inquiries proved abundantly. The conclusion was thus forced upon them that it became an essential element of duty to make a special study of this gas "we do not know of," and it was at this point that meteorological knowledge came to their aid. In the days when the science of ventilating coal mines—if science it could be called—was in its rudest form, contemporary with and anterior to Sir Humphrey Davy, observant old colliers whose working places were often found to be foul with fire-damp were wont to associate that condition with the direction of the wind, probably due to the fact that certains directions of wind in the particular locality were associated with a lower or falling condition of atmospheric pressure as indicated by a falling barometer. It would thus be seen that the association between atmospheric conditions and the presence or absence of fire-damp in the workings of coal mines was not by any means novel. In those days meteorology was an insignificant branch of the science of astronomy. Meteorology—which, technically speaking, meant the science of the atmosphere—had, however, established for itself a worthy and honorable position in the mercantile world, and this comparatively young branch of science now speculated upon coal mines. Bearing in mind the settled views held by all intelligent and practical mining men of the present day, that atmospheric pressure and moisture were influences of great potency in connection with the ventilation of coal mines, he thought no greater absurdity could be conceived than that of neglecting to apply to the best purposes the useful information and suggestions which this branch of science placed within their reach. What were formerly speculative problems are now well established scientific truths, and in deciding what to accept or what to reject it was at least desirable not to err on the hazardous side. It was not to be implied that in the well conducted operations of coal mining this important branch of science was neglected for he knew that it secured in many places a very full share of study and consideration, and with useful results. He could not imagine how anyone, having seen the sound evidences of its utility in matters concerning atmospheric influence over ventilation, could ever think of relaxing his hold upon it enabling him, as it did, to settle many important points with certainty and which must otherwise have remained in the region of dangerous doubt. He must not overlook those who seemed to prefer to live entirely free from scientific considerations, and who were content to go just so far as was required by the provisions of the Coal Mines Regulation Act, which made the existence of a barometer and thermometer a statutory necessity at the entrance to each mine. The meteorological instruments useful in connection with coal mine ventilation were the barometer, thermometer, hygrometer and anemometer, which respectively indicated the condition and changes of pressure, temperature, moisture and volume of ventilating current. Although each element had an appreciable and important significance to the responsible officials of a mine in the economy of ventilation, the premier position must be accorded to the barometer, which indicated the condition and variations of pressure. Temperature played a less important part in these days of mechanical ventilation than was formly the case under the older *regime* of the furnace, though it was a condition which had to be carefully reckoned with as being liable to exercise its most deleterious influence concurrently with other adverse circumstances of the working of the mine. Moisture, as indicated by the difference between the readings of the wet and dry bulb thermometer (hygrometer), was said to be responsible for the variation of resistance to the passage of the current of air through the air passages or galleries of the mine, but of itself it was, in Mr. Thompson's opinion, only of material importance when its influence for evil operated concurrently with other adverse elements. With regard to the volume as ascertained by the anemometer, he confessed that his mind was not free from doubt as to the absolute or general utility of such enormous volumes of air as are frequently heard of in both in practice and in project.

Artesian Wells and Water Motors.

Among the most interesting water power installations now in existence are, without a question, the artesian well plants which, of late, have gone into operation at different places in the western part of the United States. Incidentally they have given prominence to the much-neglected water motor, which for years past has led a modest kind of existence, notwithstanding its very fair claims to consideration. As a matter of fact, it has many decided advantages as a means for supplying small power, and even for comparatively large quantities some of its various modifications have been found to give very good accounts of themselves. Practically, a water motor is as easily managed almost as a water faucet. Its cost for repairs is nominal, and its first cost is exceedingly small. With this in its favor, a pretty heavy bill for water power can be afforded, and yet a considerable profit be left over steam or compressed air.—*From Cassier's Magazine for October.*

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

The Mode of Action of the Fan.—The Piston Analogous to the Fan Blades.—Velocities and Densities.—Balancing the Mine Resistance.—Velocity into a Vacuum.—Pressures and Squares.—An Example in Fan Calculation.—The Blowing Fan.—Pumps and the Velocities of Fluids.

65. **The Mode of Action of the Fan.**—In commencing to study the principle of action of the ventilating fan, we must at once dismiss from the mind the idea that the fan is either a puzzle or an enigma, that can only be solved by being immersed in the profundities of abstract mathematics, for all the haze and obscurity that envelopes the subject, is the result of believing that the mode of action of the ventilating fan is a riddle that can only be solved by special deeply learned experts, whereas any student in mining can, through the medium of ordinary arithmetic and the well known laws of mechanics, balance any equation relating to it. To make the mode of action of the ventilating fan quite understandable, let us proceed with the help of Fig. 112.

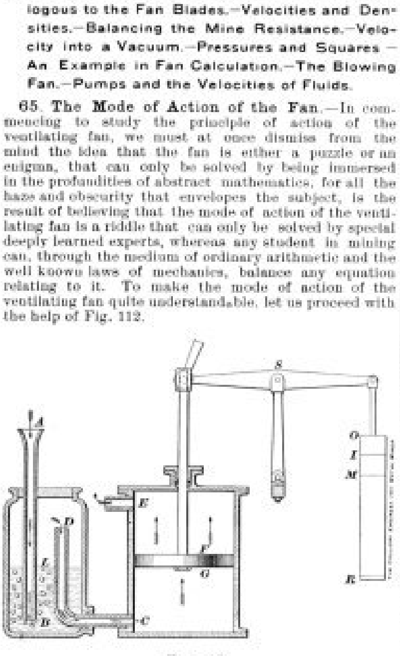


FIG. 112.

66. **The Piston Analogous to the Fan Blades.**—Here the case of the fan is substituted with a cylinder and the blades with a piston *F G*. The centrifugal machine is continuous in its action, but the piston and cylinder has an alternate action for intake and discharge, but so far as the pumping action is concerned, both are alike; and to make the piston and cylinder analogous to the fan, the port of entry on the upstroke is made to take place at *C* and the discharge at *E*. Now if the cylinder be disconnected with the vessel *A D B*, and if the ports *C* and *E* are equal, we may now proceed to try such experiments as will demonstrate the laws that govern the mode of action of such a pump. Let the area of the piston *F G*, be equal to one square foot and the area of the port of injection at *C*, 4 square inches, and let the area of the port of ejection at *E* be 4 square inches, or equal to *C*; further, let the piston be moved with an upward force of 2 pounds. Under the conditions given, the pump is similar to a fan, when situated in the open air and not subject to any mine resistance. The orifice of entry situated at the center of the fan, is the exact analogue of *C* under the piston, and the square of the velocity of the air entering the cylinder is increased or diminished directly as the depression under the piston is increased or diminished, and what is true in the principle of action, when air rushes into the depression under the piston in this case, is equally true of air entering through the central orifice into the depression in a fan. Let us here notice one thing however, and that is the ejection of the air above the piston at *F* will either be at a less velocity than that of the entry of air at *C*, or a greater pressure will be required for ejection, but if the mass of the air per cubic foot is the same at the discharge and entry of the pump, then no difference can arise, because the velocity of discharge cannot exceed the velocity of entry; therefore it follows that when the densities are equal, the pressures are equal and the velocities are are equal. In the case of an air pump or fan however, the densities of the injected and ejected air are never equal, consequently the pressures are different, and the velocities are different, but the masses of air entering and leaving a pump or fan in a given time are always equal. All these peculiar statements may seem very strange, but we cannot understand the action of a fan without being first made aware of how the elasticity of the air affects its mode of action; and further, if we refer to the figure we will see that when the piston moves upward the air above it is compressed while that beneath it is rarefied, with the result, that a pound of compressed air is smaller in volume than a pound of thin or rarefied air, consequently as we mean by mass, the quantity or weight of air, it is clear, that a greater or less weight of air cannot leave a pump or fan in a given time, than that which enters it, but a large volume of rarefied air, may be only equal in weight to a small volume of heavy air, and if the volumes are different the velocities must be different. For example, the density or weight of air varies directly as its pressure. Then take the pressure of air to be about 2,130 lbs. per square foot, and if the pressure be increased 1,000 pounds, and if the weight of 13 cubic feet of air is 1 pound, the same volume will now weigh $\frac{(2,130 + 1,000) \times 1}{2,130} = \frac{3,130 \times 1}{2,130} =$ 1.469 pounds, or let the pressure be reduced 1,000 pounds, then the weight per 13 cubic feet will be $\frac{(2,130 - 1,000) \times 1}{2,130} = \frac{1,130 \times 1}{2,130} = .5352$ pounds.

67. **Velocities and Densities.**—Here then we see clearly that to make the mass entering the pump equal to the mass discharged by it, the velocities will be inversely as the weights of the masses per cubic foot, or per 13 cubic feet. Then if we take the velocity of the heavy air to be one, that of the light will be $\frac{1.469}{.5352} = 2.744$.

Let the reader be careful to duly appreciate these fine points, and his progress will be quicker after. Now let us introduce the mine resistance that the fan must overcome and will we discover the great importance of the matters we have just discussed. Connect *A D B* with the port of entry at *C*, and let us observe that we are about to imitate the mine resistance by causing the incoming air to blow through a stratum of water 2 inches deep as at *L*, and when the piston ascends, it is clear that two things will occur. First, the mine resistance *M R* will require extra force like the weight *M R* to overcome it; and second, the increased mine resistance will reduce the atmospheric pressure, and hence the air will be rarefied. 2 inches of water-gauge being equal to 10.4 pounds per square foot, the weight of air must be reduced as $\frac{(2,130 - 10.4) \times 1}{2,130} = .995$ or from 1 to .995. This appears to be a small reduction, but when we notice that the mine resistance and the consequent rarefaction affect the result as a square, we can realize the importance of the matter, as $\frac{2,130}{(2,130 \times 10.4^2)} = \frac{2,130}{2238.16} = .951$. It will be shown further on, that the mine resistance alone gives to this class of centrifugal pump a diminishing ratio of exhausting efficiency, but there are other negative or antagonistic factors that convert a diminishing, into a vanishing efficiency.

We see that a centrifugal fan can only establish a perfect vacuum at its orifice of entry, by making an infinite number of revolutions in a limited time, but with a considerable mine resistance, the infinite number of revolutions would be reached long before a depression equal to half the pressure of the atmosphere was reached.

68. **Balancing the Mine Resistance.**—Refer again to the figure and notice that if the counterbalance weight *M R*, weighed exactly 10.4 pounds, or a weight equal to the current pressure due to 2 inches of water-gauge, no air would enter by *C* or leave the cylinder at *E*, because the piston would only rise until it had made a depression equal to a reduction of pressure of 10.4 pounds per square foot, and the air could not enter through *A* and blow through the water in bubbles, escaping at *L*. Here, then, we see clearly that neither a pump nor a fan has any spare energy for injection or ejection until the mine resistance is balanced. Set above the weight *M R*, the weight *M I*, and this will represent the force required for injection, and upon *M I* place *I O*, and this will represent the force required for ejection,

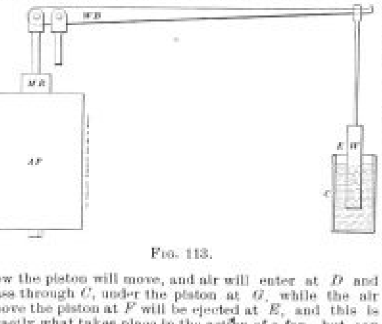


FIG. 113.

now the piston will move, and air will enter at *D* and pass through *C*, under the piston at *G*, while the air above the piston at *F* will be ejected at *E*, and this is exactly what takes place in the action of a fan; but, say you, rarefaction does not come in here. Pray look again, and you will find it does; and to assist the investigation, Fig. 113 is introduced. The figure is that of a lever balance. *A P* is a heavy weight to indicate the atmospheric pressure and *M R* is the mine resistance, *A P* + *M R* being the denominator of the fraction that will just now engage our attention. *A P* + *M R* are balanced by *E*. *E* is seen to be immersed in water *W*, in a cistern *C*, and the object of this arrangement is to illustrate the diminishing power of the fan as the result of the rarefaction due to the mine resistance, for just as the weight *E*, could not balance the weights *A P* and *M R* if it was entirely immersed, so the rarefaction of the air within a fan fixes an unalterable limit to the velocity of the air into it, that cannot be increased or diminished without increasing or diminishing the velocity of the fan. Consequently, to find the ventilation due to the action of a given ventilating fan, the factors required are:

1. The revolutions per minute.
2. The diameter.
3. The radial length of the blades.
4. The areas of the orifices of entry and discharge.
5. The mine resistance.
6. A fractional constant of efficiency.

Keeping in view the fact that Fig. 112 is a complete illustration of the mode of action of a fan, we will now proceed to still further establish that conclusion.

69. **Velocity into a Vacuum.**—At atmospheric pressure the velocity of air rushing into a vacuum is equal to 1341.+ feet per second, and the square of that velocity gives a number that we often require in fan calculations, namely, 1,800,000.

The reader will remember that *C* and *E* were supposed to have a sectional area of 4 square inches, and that after making *M R* = 10.4 pounds per square foot, *M I* for the depression was 1 pound and *I O* for the compression of ejection was 1 pound, therefore the total weight, or the analogue of the engine turning the fan was 10.4 + 1 + 1 = 12.4 pounds.

70. **Pressures and Squares.**—Again we noticed the effect of the rarefaction and resistance of the air, and to allow for these we proceed as follows: Call the mine resistance *M* and the calculated centrifugal force *T*, and the moving force remaining after the mine resistance has been deducted *F*, and the pressure of the atmosphere in pounds per square foot is 2,130 pounds, and remembering that the pressures that give motion to fluids are alway in the proportion of the squares of the velocities of the fluids, we can by an easy process in figures, determine the velocity of the air on entering *C* after passing through the resistance in the bottle *A D L*. For if the pressures and squares are directly proportionate to each other, which they are, then *T* — *M* is equal to the numerator of the fractional portion of 1,800,000, which is the equivalent of the square of the velocity of the air in feet per second. In the case before us $\frac{T - M}{(2130 + M)} \times 1,800,000 = \frac{2}{2238.16} \times 1,800,000 = 1608.46$, and the velocity is, therefore, in feet per minute $\sqrt{1608.46} \times 60 = 2,400$.

We can now see how to find the velocity of the air entering a fan, and we must be careful to notice two things in relation to this matter. First, by the water gauge we can find the velocity of the ventilating current in an air-course, but we *cannot* by the water gauge alone find the quantity of air passing through a fan.

All this appears plain enough, but there are other modifying factors that must be explained before calculations can be made that will give correct results.

For example, the relative areas of the orifices of intake and discharge seriously influence the results, but to keep the reader abreast of the subject so far as we have advanced with it, let us give an example to illustrate what has been learned; and let us further say that after the whole matter has received exhaustive treatment, numerous questions and answers will be given to show how the values in eace case are determined.

71. **An Example in Fan Calculation.**—A ventilating fan for a mine is 20 feet in diameter; makes 80 revolutions per minute; the radial length of the blades is 6 feet; the orifices of intake and discharge are equal; the mine resistance is equal to 12 pounds per square foot, and the reduction of flow due to the contraction at the orifice of entry, commonly called the *vena contracta*, is .6. What then is the quantity of air per minute passing through this fan?

ANS:—First find *T* the pressure due to the radial column. The radius of gyration is 4 + 3 = 7 or half the length of the blades added to the radius of the orifice of entry; and the mean diameter then is 14 feet. The mean velocity in feet per second is

$$\frac{14 \times 3.1416 \times 80}{60} = 58.6432.$$

Taking the average weight of a cubic foot of air to be .0766 the weight of the radial column will be 6 × .0766 = .4596, and as the tangential force varies as $\frac{V^2 W}{3.1416\, g} = F$, then *T* will be equal to $\frac{58.6432^2 \times .4596}{3.1416 \times 32.16} = 15.644$ pounds per square foot.

And the square of the velocity of the air entering the orifice of the fan will be

$\frac{(T-M)\times 1,800,000}{(2130+M^2)} = \frac{(15.644-12)\times 1,800,000}{(2130+12^2)} = \frac{3.644\times 1,800,000}{2274} = 2884.32$. The velocity into the orifice of entry will be in feet per minute $\sqrt{2884.32}\times 60 = 3222.415$. The area of the orifice of entry into the fan is $8^2\times .7854 = 50.2656$ and taking the co-efficient for the *vena contracta* at .6, the quantity of air passing through the fan per minute will be $50.2656\times .6\times 3222.415 = 97186$ cubic feet.

Let us not forget that for reasons that will afterward be given .6 has been found as low as .3 with the consequent bad results. The example just worked out demonstrates the accuracy of the process, and to still further sustain the conclusions arrived at, let us take the case of a fan set in the open air and therefore having no resistance at either intake or discharge, and to make the contrast show a marked difference, let us take all the values given for the last example except the mine resistance, which will not occur. We can see at once that the whole of T will be available for the injection of air into the orifice of entry and for discharge, and it is also clear that the pressure of the external air is not by any speed of the fan reduced at the entry, but the density and pressure of the air at the moment of discharge is increased, therefore the resistance set up is directly as the pressure or $\frac{T\times 1,800,000}{(2130+T)}$ = the square of the required velocity.

Carefully notice the T is not squared before being added as was the case with M, because there is no rarefaction due to T; then as we found in the last example that $T = 15.644$, it follows that the square of the velocity in this case is $\frac{15.644\times 1,800,000}{2130+15.644} = \frac{15.644\times 1,800,000}{2145.645} = 13,124$ and therefore the velocity per minute is $\sqrt{13,124}\times 60 = 6,873.574$ and the quantity in cubic feet per minute passing through the fans is $.6\times 8\times 8\times .7854\times 6,873.574 = 207,303$. From this example we learn an interesting fact, namely, that with the same velocity of the fan the value of T remains, but the mine resistance reduces the quantity from 207,303 to 97,186 cubic feet; or 12 pounds per square foot of mine resistance reduces the quantity in this case from 1 to $\frac{97,186}{207,303} = .4689$. After this the water gauge can only be taken as a negative and uncertain index of the quantity of air passing through a fan.

72. The Blowing Fan.—To still further make the the facts under discussion cohere we introduce Fig. 114

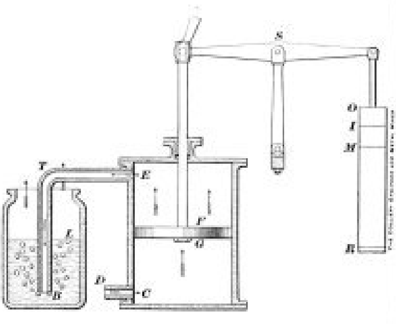


FIG. 114.

as an illustration of the mode of action of the blowing fan, and it will be seen that two things occur that set the blower in strong contrast with the exhauster, and the first is the pressure of the external air at the orifice of intake is invariably atmospheric pressure, and that the pressure at the orifice of discharge is always above atmospheric pressure. The second point of contrast is the pumping efficiency of the blower is greater than that of the exhauster, and the diminution of efficiency in the blower takes place more slowly than in the exhausting fan. For example, the atmospheric pressure at D, before the port of entry C, is uniform, whereas the compression at E increases; and to prove this, remove the weights MI and IO and RM will just balance the resistance in the bottle, for the water in the tube T will just reach the bottom without blowing through. Therefore MI and IO represent the depression within the fan and the compression at the exit from the fan as before, and to sustain the claim of the second point, let us first notice that instead of the denominator of the fraction for finding the square of the velocity being as before $(2130+M^2)$, it is now $(2130+M)$, and for illustration let us use the former values of the exhauster to find a result with the blower. T was 15.644 and M was 12; the square of the velocity will therefore be $\frac{(T-M)\times 1,800,000}{(2130+M)} = \frac{3.644\times 1,800,000}{2142} = 3,062.3$ and the velocity in feet per minute will be $\sqrt{3,062.3}\times 60 = 3320.3$, and the cubic feet per minute passing through the fan will be $.6\times 8\times 8\times .7854\times 3,320.3 = 100,138$. Then under the same conditions of mine resistance and velocity, the same fan exhausts 97,186 cubic feet and blows 100,138 or a difference in favor of the blower of $100,138 - 97,186 = 2,952$ or an advantage of a little over 3 per cent. At higher velocities the blower leaves the exhauster far behind; and when the reader has learned the lesson, as taught with the illustrations, he cannot fail to see the loss due to the rarefaction in the drift.

75. Pumps and the Velocities of Fluids.—Fig. 115 introduces another phase of the operation of the same law as illustrated with a piston moving in advance of the ascending water column.

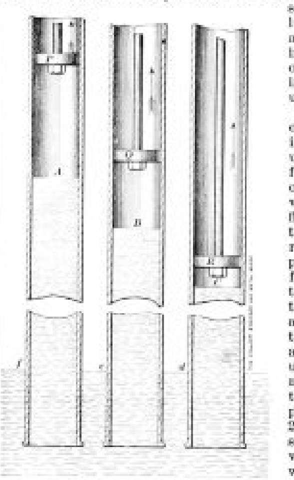


FIG. 115.

The velocity of water rushing into a vacuum is 46.819 feet per second, and as the velocities of fluids vary as the square roots of the pressures, it follows that the squares of the velocities are directly as the pressures, and the pressure of the atmosphere is, therefore, proportionate to 2192.2, the square of the velocity of water rushing into a vacuum. Water rises to an elevation of 34 feet in a vacuum, but it requires time to ascend to that height, because of its inertia and the friction of the sides of the chamber it moves in. 46.819 feet per second is equal to 2809.14 feet per minute, and as this velocity is calculated without allowing for frictional resistance, let us make it for illustration nearer what it should be, 2,400 feet per minute, or 40 feet per second, or the square of the velocity in feet per second is 1,600 when allowance is made for incidental resistance. To make the matter clear, let us begin with an example.

The piston of a pump is situated at an elevation of 16 feet above the ingoing water that is in course of being pumped, what should be the maximum velocity of the piston?

ANS:—Now as a 34 feet column of water will balance the pressure of the atmosphere, it might be thought that the velocity would be as follows $\sqrt{\frac{(34-16)\times 1,600}{34}}$ = the velocity per second, but before the column can move, the inertia of the 16 feet of column must be overcome, and the mass set in motion, therefore as in the case of the blowing fan the velocity will be found as follows:

$$\sqrt{\frac{(34-16)\times 1,600}{(34+16)}} = \sqrt{\frac{18\times 1,600}{50}} = 24 \text{ feet}$$

per second, or $24\times 60 = 1,440$ feet per minute, and as the valves require force to lift them, and a still further interference of the *vena contracta* takes place, it is probable that the velocity is still much less. We see then that the efficiency of a water pump is a vanishing ratio, for let us suppose the piston is to be situated at an elevation of 24 feet, then

$$\sqrt{\frac{(34-24)\times 1,600}{(34+24)}} = \sqrt{\frac{10\times 1,600}{58}} = 16.6 \text{ or}$$

996 feet per minute. A double acting pump then, with a 6 feet stroke and making 100 strokes per minute would lose the $\frac{(100-83)}{100} = .17$ of its stroke at every lift as shown at RC and at a higher piston speed the loss of water lift would become like QB or PA.

The *vena contracta* so powerfully interferes with the inflow at the orifice of entry, that the piston may be set to work below the level of the feed water and yet at a high speed it may outrun the column as at Rb and ag Fig. 116. C is the surface level of the feed water, and by a thoughtful inspection of the last two figures the causes of the diminishing efficiency of machines of the fan class can be so understood, that the succeeding lessons on the subject will heighten and deepen the interest called forth in the investigation of the matter.

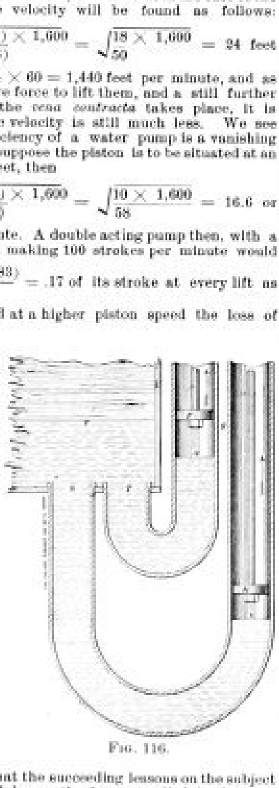


FIG. 116.

[TO BE CONTINUED.]

GEOLOGY OF COAL.

The Varieties of the Cephalopoda.—The Conifers of the Devonian Period.

51. The Varities of the Cephalopoda.—The recurrences of invariable law, make the past and the present one grand harmonic, and but for this concord in the pulse of life that beats true to the same time for ever, the past would be concealed in the impenetrable darkness of the infinite. We can therefore read the past by the present, because the biology of to-day, is only a reprint of that of all the ages that are gone, and knowing this, our faith is as satisfying as the evidence of a fact, and we can therefore with this assurance, dare to restore as a mental conception the life of former eons, and the fauna and flora of former lands.

From the standpoint just assumed let us then associate the present with the past by finding examples of progression in succession arising from the altered and improved life conditions of each succeeding vast period of time, and where can we look for a better example of these progressive and successive changes, than that which characterizes the most highly organized mollusks the cephalopods. They first appeared in rocks of the Cambrian age as the orthoceras and persisted into the Carboniferous period when the orthoceras vanished forever. Fig.

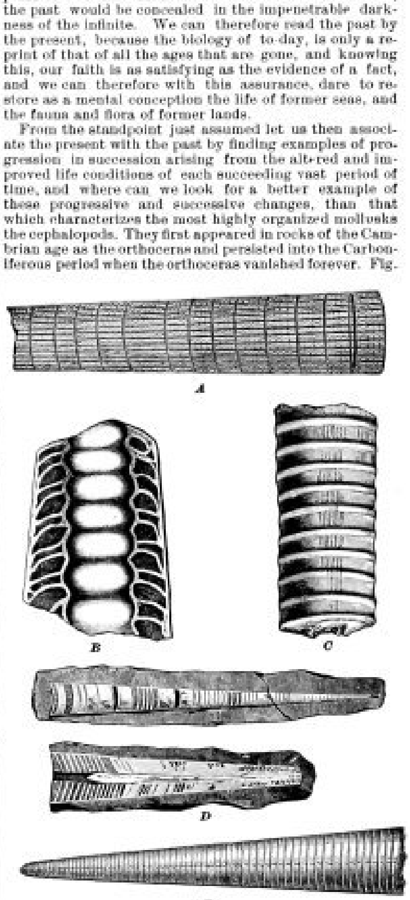


FIG. 85.

85, A, B, C, D and E, are Silurian examples of the straight shells or long-horns or orthocerites. This singular mollusk lived in a shell divided by septa or transverse plates or partitions into chambers, through the whole of which passed the siphon or siphuncle, and the head with its beaked mouth was set in the midst of the roots of its tentacles, or arms for seizing its prey, hence it was head footed, or was a cephalopod. The tentacles were and still are covered with vacuum discs or suckers, hence the danger of being attacked by the living cephalopod or cuttle fish.

By Fig. 86, it will be seen that the orthoceras became early in the Silurian period an open coiled "ram's horn" or a modified orthoceras, as *Lituites cornu arietis*, at D, and this change continued until the coils of the shell became close, and then we had examples of the beautiful ammonites, where the junctions of the septa with the hornlike shell cause these pretty curling ridges such as are seen on B as lines, and on A as indicating the boundary lines of the septa where they are joined to the

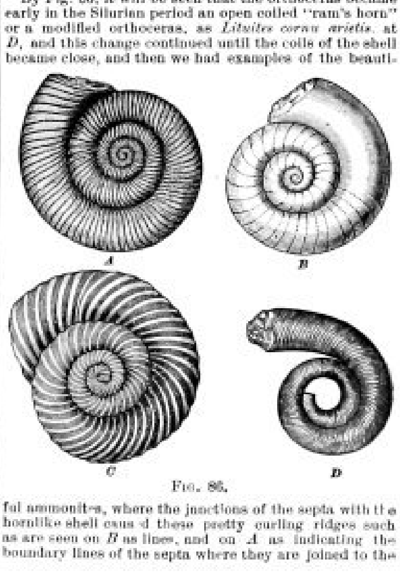


FIG. 86.

shell; but these ridges are still more developed on *C*, and are the embryo of the spinelike processes of the magnificent shells of the ammonites of the Cretaceous period. The cephalopods are found as long horns in the early Cambrian, and continued right on into the Carboniferous period. During the Silurian period some varieties became curled as open coils, and others became close coiled as ammonites and the true ammonites are only now represented in our seas by the pearly nautilus, but the cephalopods as naked or shell-less cuttle fishes swarm in our seas to-day, and they are distinguished from the shelled variety by being Dibranchs, the other being Tetrabranchs, that is the naked present day cephalopods, are more highly organized than their predecessors being Dibranchs, or two gilled, the shell varieties being Tetrabranchs, or four gilled. The gills of a fish are the substitutes for the lungs of the higher orders of animals, it is by the gills that oxygen is collected from the water to aerate the blood of the fish. Now as the cephalopods of all the ages, have been strongly characteristic and distinctively different, they furnish unsurpassed indices of the periods, and therefore are worthy of the closest attention.

52. The Conifers of the Devonian Periods.—Fig. 87 is an illustration of the cell walls of the woody fibre of the fir or conifer. These lines or vesicles and

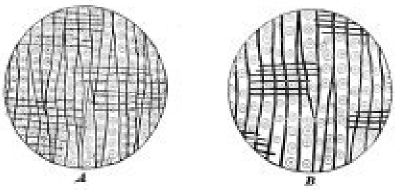


Fig. 87.

discs have given distinctive character to the wood of the conifer from Devonian to the latest times, *A* is an example of the fossil wood, *B* is an example of the latest firs. Perhaps none of our forest trees have altered so little during the mighty march of time, as the fir. They are first found as gymnosperms, and they are gymnosperms still, that is their ovules or seeds are matured in nakedness. The conifer of the Devonian period then is of great interest as proving that the dry land and climate of that time was the beginning of the morning of the period wherein all the life forces made their strongest manifestation in the production of the prodigious plant growth of the Carboniferous period.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

Units of Electrical Measure—Correct Ideas of Electrical Terms—High and Low Tension—Amperes and Volts—Volume and Intensity—The Coulomb and Heat Units—Electric Resistance—The Transmission of Energy.

62. Units of Electrical Measure.—The basis of all knowledge and civilization is found in units of extension, volume, energy, weight, measure and value, and the difference between ignorance and knowledge can be discovered on hearing men speak. The ignorant man says, "there was such a tremendous lot of people there," the educated man says "he estimated the crowd at 360 persons." Fancy men saying, "it is *such a strong* current of electricity," by this statement we have no idea whatever of true value.

We clearly see then that units of measure for estimating the value of energy are indispensably necessary, and further, as electricity is a mode of molecular motion the units of its measure must be of a like character to those used in other branches of mechanics such as time, mass and velocity. And such is actually the case for we have the Coulomb for time *one second*, the ampere for mass or flow and the volt for velocity or pressure. 1 volt multiplied by 1 ampere gives .7373 of a mechanical unit of work per second, and what is called a Watt consists of 746 of these .7373 of a foot pound units per second. This makes the electrical mechanical units harmonize with those of steam.

For example, a horse power per minute consists of 33,000 units of work, as established by Watt, or $\frac{33,000}{60} =$ 550 units of work per second, and $\frac{550}{.7373} = 746$, or $746 \times .7373 = 550$, then as an electrical unit of work is only .7373 of a foot pound, 746 of these are equal to 550 foot pounds done per second, a true Watt.

63. Correct Ideas of Electrical Terms.—As our fore-fathers called electricity a fluid, we continue even yet to speak of it as *flowing*, and no doubt this mode of speaking will continue until our children and successors have found out all the possible uses and the machines requisite for the application of electricity, when those that follow will reform the terms, and introduce others that will correctly express what is meant. In the meantime we have to say much to make the terms understandable, for example, a foot pound is either the equivalent of one pound being lifted one foot high, or that of a force of one pound being exerted through the space of one foot, in overcoming a resistance of one pound, so the electric .7373 of a foot pound, is the unit of work done, when a force of one volt lifts one ampere through the length or resistance of one Ohm.

Fig. 106 is to explain the relationship of the volt to the ampere, or the velocity to the mass. At *B* we see a small weight shown as 1 *A*, that is 1 ampere, at an elevation of 10 *V*, or ten times that of 1 *V*, now $10 \times 1 = 10$, that is 10 of the 746 units of a Watt, again $10\ A \times 1\ V = 10$ Joules.

64. High and Low Tension.—From the standpoint, however, of heat, the voltage is sometimes spoken of as high and low tension, or of greater and lesser intensity, and as the necessary explanation of the relationship of mass and intensity as found, say in different volumes of water, will aptly illustrate the uses of the electric units. We will now consider the matter through the medium of light and heat. Let the circu-

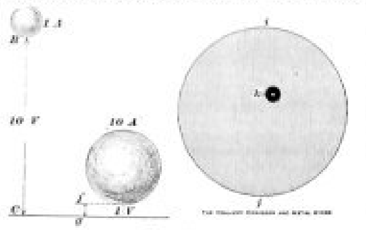


Fig. 106.

lar disc *i j*, represent the face of the full moon, and we can realize the fulness of the volume of pale soft light that illuminates at once, half the surface of the earth, and although the intensity of the light is low, yet the quantity of that feeble light is enormous, or it would be said in electric terms, the amperage is very great but the voltage is very small. On the disc is seen a white spot in the middle of a black one at *k*; this small white spot is to show that the intensity or tension of the light of a candle very far exceeds the reflected light of the moon, yet it is so small in quantity, that at a distance of 20 feet, the more intense, and yet infinitely smaller volume of the candle light is drowned in the ocean of moon light. The voltage then of the candle flame is very high, while the volume or amperage is very small, on the principle just explained, of 1 *A* falling 10 feet being equal in work to 10 *A* falling 1 foot. Now the area of the illuminated hemisphere of the moon is so vast compared to the surface of a candle flame that to make their illuminating powers equal, notwithstanding the high intensity of the candle light, the latter would have to be so increased in intensity that the light of every sun in the universe would be darkness compared to it.

64. Amperes and Volts.—Fig. 107 furnishes an example in contrast, of a great intensity accompanying a great volume, and a moderate intensity associated with an exceedingly small volume, the former is that of the sun at *S* and the latter is that of a candle at *C*. Now the sun not only illuminates the earth, but all the

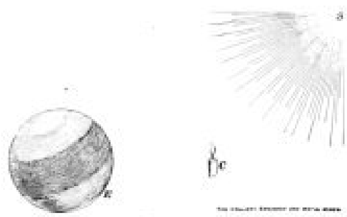


Fig. 107.

planets in the solar system, and while the light of the candle would be washedout by the vapor in the air at a distance of a few feet, the light of the sun penetrates the measureless depth of space. The candle would illuminate a few feet, while the sun covers one-half of the earth with a vastly more intense light.

65. Volume and Intensity.—The electric light can be made equal in intensity to the sunlight, but the volume of the electric arc is not larger than the flame of a small candle; so intense is the light of the arc, however, that if it is thrown on a screen, and a burning candle is interposed, the light of the candle appears in the disc as a shadow, as shown at *S* Fig. 108. *E* and

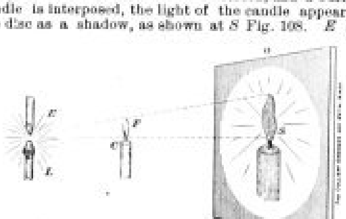


Fig. 108.

L are the carbon pencils of the electric lamp. Here then we find very high tension of light in the electric arc, accompanied with a very small volume, and therefore a relatively small area is illuminated. and we now can show that if all the electric lights in the world were located in one small space, they would conjointly only make a small fraction of the illuminating power of the moon. The electric light then is high in intensity, but very small in quantity, while the moon's light is low in intensity but very large in quantity compared with artificial lights.

66. The Coulomb and Heat Units.—Water furnishes some excellent illustrations of the volt, ampere, and coulomb; for example, suppose the temperature of a pound of water is raised from 87° to 212° or boiling point, and that the temperature of 100 pounds of water is raised from 87° to 89°, to which of the two masses of water has the most heat been given? Here it is again a question of volume and tension, the boiling water is very hot, its temperature has been raised from 87° to 212° or increased by 125°. Now if the one pound is taken as the unit volume for measuring quantities of heat, then $100 \times 2 = 200$, that is to say we have imparted to the one pound of water 125 heat units, whereas we have given to the 100 pounds of water 200 heat units, or we may say the heat units in the one pound of water are 212, whereas the heat units in the 100 pounds of water are $89 \times 100 = 8,900$; or we may say the intensity or voltage of the heat in the one pound is equal to 212 volts and the volume or amperes are equal to 1 or $212 \times 1 = 212$ joules, and the intensity or voltage in the 100 pounds is 89, and the volume or amperes are 100, therefore $89 \times 100 = 8,900$ joules. The common illustration is that of comparing the energy due to moving fluids, with that manifested by electric action, and to make this mode of presenting the case clear Fig. 109 is introduced. Here

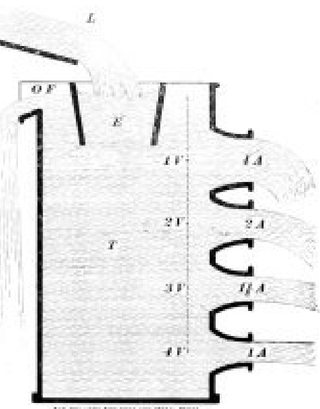


Fig. 109.

a vessel is contrived in such a way that water is made to pour out of four orifices all of different sizes and subject to different pressures, now the pressures are taken to represent volts, and the quantities per second as amperes, and to secure continuity in the pressures or volts, the water level in the tank *T* is kept uniform by making an excessive inflow from the spout *L*, and an overflow as as at *O F*; further to keep a steady level the inflow is into a funnel *E*, where the movement of the agitated water at the foot of the fall is prevented from disturbing the level. Now the pressure at 1 *V* is intended for one volt, while the outflow being 4 unit volumes, is made to represent 4 amperes, then $4 \times 1 = 4$ joules, then at 2 *V* we have double the depth made to represent 2 volts, and the outflow is 2 unit volumes, then $2 \times 2 = 4$ joules as before. Again, $3 \times 1\frac{1}{3} = 4$ joules, and $4 \times 1 = 4$ joules. Now the pressure or volts is greater for 2 *V* than 1 *V*, but 2 *A* is contracted so that the outflow is only ½ that of 4 *A* but as ½ the volume or amperes is subject to twice the pressure voltage, then the joules remain the same for 2 *A* as for 4 *A*, and the same reasoning applies to the others.

67. Electric Resistance.—The electric current when transmitted through a cable, furnishes the same mode of action as gases and liquids transmitted through pipes, and the liquid, say water, may be taken illustratively to represent amperes and the pressure, volts; and if the same volume, or amperes is passed through a pipe at double the pressure but with the same velocity, then the same flow will do double the number of units of work. The same characteristic is found in steam, but perhaps the most peculiar phase of the matter is this: If you double the velocity of water through pipes you very much increase the friction, so that to double the units of work in a limited time, by doubling the volume or flow without increasing the area of section, a great loss of useful effect is the sure result. The same law is found in the transmission of steam, when the steam pipes are too small in transverse section, the velocity of steam on its way to a fast running engine is retarded by greatly increased friction and consequent loss of energy; and stranger still, electricity behaves in its transmission through a cable like liquids and gases through pipes, so that if you increase the amperes or flow to increase the work done, the chances are that you may fuse the cable, or destroy the solenoids of the motor; because when an electric current meets with resistance in its path, the electric, is at once converted into heat energy. But if you double the volts or pressure of the current, you double the work done without increasing very much, the resistance and loss.

Miners are apt to confound current pressure with the total pressure of, say air, and conclude that the velocities of the air through the pipes will vary as the square roots of the *total* pressures. This not being so, let us at once set the matter right by saying that if we double the total pressure of the air we double its weight and therefore, double its current friction, but we still obtain twice the effective work done because we have not altered the percentage of loss due to current friction, the speed of the air in the pipes being still the same, and two per cent. of thin air has exactly half the resistance due to 2 per cent. of air twice as heavy, and the heavy air does twice the work for twice the friction. Total pressure and current pressure are therefore very different things.

As it is such a difficult matter to increase the amperage of an electric current beyond the conducting capacity of the wire, you will hear people speak more of increasing volts than amperes.

68. The Transmission of Energy.—Fig. 110, is given to illustrate the laws of the transmission of energy by gases and liquids through pipes; and to correlate this fluid transmission with that of electricity through cables, we should keep in mind the fact that the rate of speed or rate of flow is a matter that must be considered as well as the area of the transverse section of the pipe, for through a large area the volume, say 1,000 gals. per minute, may flow at a much lower velocity than the same volume through a small area, and here again, we find the same fact exemplified in the electric cable, but the same quantity flowing through the small pipe can only do so at an increased pressure because it offers a greater resistance, and thus introduces the electric unit of resistance the Ohm. Through the sections shown in the figure, at Q, R, T the quantities are 49 A, but the pressures are different, because the currents are supposed to have shorter and longer lines of resistance, thus teaching the lesson that the amperage being the same, the Ohms of resistance are proportionate to the voltage of the current. To obtain the passage of the same quantities through W and X as through U, it is seen that the voltage has been increased to 40 and 100.

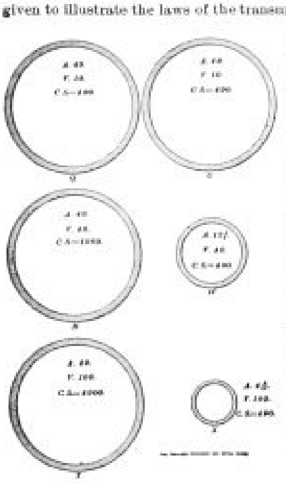


Fig. 110.

[TO BE CONTINUED.]

MINING METHODS.

Mechanics of Fluids in Motion—The Water-Gauge—The Difference of Potential—Static Air Pipes.

62. Mechanics of Fluids in Motion.—The water-gauge does not only measure current pressure, but inferentially it also measures current speed, and really, in mining the use of the gauge lies chiefly in the direction of determining the current speed, because in the mine itself, the pressure producing the ventilation is directly proportionate to the current resistance. Fig. 110 illustrates the use of the gauge for three purposes. First, to determine the value of the pressure producing the draught through the furnace; second, to determine the quantity of air used in the combustion of the fuel, and third, to ascertain the temperature of the hot gases in the chimney. It is true, the gauge measures directly, pressure only, but from the pressure can be deduced the velocity, because the current pressure varies directly as the resistance, and from the current pressure gauge the motive column can be found, and from the motive column the temperature can be calculated, so we see the gauge $W G$, connected at P with the chimney flue C, is of great value in gauging the efficiency of a furnace, and the waste or otherwise of heat that is allowed to escape with the products of combustion into the chimney flue.

Now, if all these facts can be determined by finding the motive column $M C$, who can underrate the economic use of this instrument?

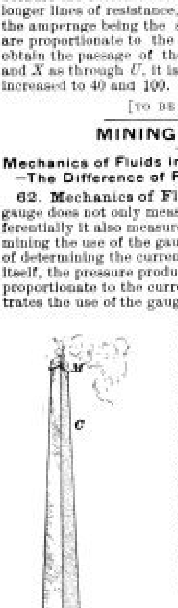


Fig. 110.

63. The Water-Gauge.—Fig. 111 is another modification of the water-gauge for determining the current *potential* between two points in an air circuit; for example, the ordinary gauge can be, and is used for this purpose, but there are conditions under which it cannot be so used. When the ordinary gauge is connected with the fan drift it measures the potential or total pressure of the ventilating current from surface back to surface, but when the water gauge is fixed at the bottom of a downcast shaft, and there connected with the return air current, before entering the upcast shaft, the gauge now only measures the potential of the current between shaft bottom and shaft bottom, and if the pressure or potential due to the underground galleries is subtracted from the fan drift reading, the difference is the potential of the shafts.

Fig. 111.

Suppose, however, we require to know the current pressure at the working face, then with the ordinary gauge, that could only be done by carrying a small pipe from the bottom of the downcast shaft to the face, and screwing on the gauge, when the *static* pressure in the tube would be that at the downcast shaft and the reading would be the potential between the two points. Now if the face was distant from the bottom of the downcast shaft one-third, and from the bottom of the upcast shaft two-thirds of the entire length of the current circuit, then the potential between the working face and the bottom of the upcast shaft would be twice that between the face and the bottom of the downcast shaft. By potential is meant possible power, but as the velocity is supposed to be the same throughout the circuit, then the potentials and pressures will be directly proportionate.

64. The Difference of Potential.—The instrument before us is used then to determine the difference of potential between the bottom of the downcast shaft, or the fan drift at the surface, or between any required points in the workings, and before explaining its mode of action, let us explain its principle of construction. It first consists of a glass jar, or white glass bottle, the mouth of which is closed with an india rubber bung B, through which a small glass tube is made to fit tight, and the lower end of the tube is made to dip into the water W. A thermometer T is placed within the bottle, and is seen to be also dipping into the water. The principle of action is as follows: First, the small glass tube is drawn up a little, so as to allow air to enter the bottle at the point of maximum or minimum pressure, or the bottle may be so canted that the water will uncover the bottom of the tube and allow the air to enter or leave the instrument, and so equalize the pressure within and without. When the pressure is balanced the thermometer is carefully read and the temperature recorded.

The gauge is now carried to the point in the workings where it is required to know the difference in potential, when if the water rises up the tube A, to an elevation $b\ a$, we know the pressure of the air within the bottle is greater than the pressure of the air without, and if $b\ a$ reads 5.38 inches, then the difference of potential would be 5.38 inches but for the interference of the altered temperature of the air within the bottle, and for this, a correction must be made. Suppose the temperature when the balance was made was 65° F, and now it is 70° F at the working face, let us find how high a rise of temperature of 5° would raise the column within the tube, if a column of 408 inches of water balances the pressure of the atmosphere.

By Boyle's law

$$\frac{(460 + 70)}{(460 + 65)} \times 408 = \frac{530}{525} \times 408 = 411.88.$$

That is, the pressure of the atmosphere would be increased by a rise of 5 degrees of temperature, in a *confined* space, from 408 to 411.88 or 3.88 inches, but the gauge reads 5.38 inches, therefore $5.38 - 3.88 = 1.5$ inches. The difference of potential then is in the proportion of 1.5 inches of water gauge.

65. Static Air Pipes.—Having made quite clear the meaning of a "difference in potential," we can now apply the principle in elucidating other practical applications of it; for example, at the Seaham and Silksworth collieries, England, static pressure pipes are carried from the junction of the return airway with the upcast shaft, as at RP, Fig. 112, up the upcast shaft and to some point on the surface as at G. The course of the static air pipe is up the dumb drift DD, and onward up the shaft.

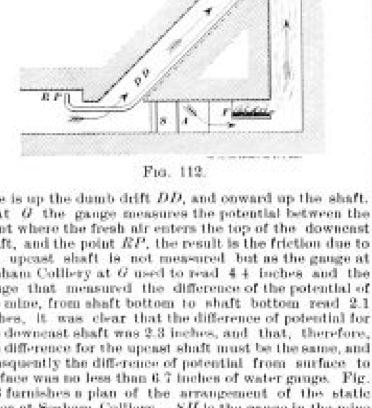


Fig. 112.

At G the gauge measures the potential between the point where the fresh air enters the top of the downcast shaft, and the point RP, the result is the friction due to the upcast shaft is not measured but as the gauge at Seaham Colliery at G used to read 4.4 inches and the gauge that measured the difference of the potential of the mine, from shaft bottom to shaft bottom read 2.1 inches, it was clear that the difference of potential for the downcast shaft was 2.3 inches, and that, therefore, the difference for the upcast shaft must be the same, and consequently the difference of potential from surface to surface was no less than 6.7 inches of water gauge. Fig. 113 furnishes a plan of the arrangement of the static pipes at Seaham Colliery. SH is the gauge in the mine superintendent's office at home. U is the top of the upcast shaft, and D is the top of the downcast shaft. G 2.1 is the reading of the water gauge at the bottom of downcast shaft or B of P. FH is the mine foreman's office at home where the second gauge is fixed, and O is the colliery office where the third gauge is fixed.

At each of these three stations the gauges read alike excepting during stormy weather, when difference of one or two-tenths often occur, nor need this be wondered

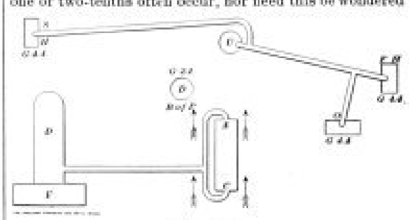


Fig. 113.

at when when we notice that a velocity of the wind of 14 miles per hour is equal to a pressure of one-tenth of an inch of water gauge, and that a velocity of nearly 20 miles an hour produces a pressure of two-tenths of an inch of water gauge.

Here is another illustration of the care required in looking for causes of error in water gauge reading. If a house A, and one C, at opposite ends of a block are connected with gauges and static pipes to a fan drift D, when the wind is blowing as indicated by the arrows, the gauge at C always reads higher than the gauge at A. Now as we have shown a small velocity of the wind will produce a pressure equal to $\frac{1}{4080}$ of the pressure of the atmosphere, that is to say $\frac{1}{10}$-inch of water gauge is equal to $\frac{1}{4080}$ of the total pressure of the atmosphere and therefore the readings of the gauge are very susceptible to false indications. Fig. 114 is an illustration of the water gauge in common use, and it will be seen that the syphon tube has one limb open to the external air at C where it is somewhat contracted to exclude dust, the other limb is connected by a static pipe A passing to the fan drift; a movable scale is seen at $D\ E$, and this scale is movable and adjustable by the screw G that is turned by the milled head T.

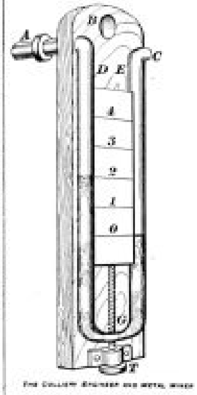


Fig. 114.

To read the gauge, turn the knob T until the zero of the scale O, is level with the water in the limb C, then read off at the high level in the limb A, and in this case the reading is two inches of water gauge or a pressure of $2 \times 5.2 = 10.4$ pounds on the square foot.

[TO BE CONTINUED.]

THE CAPELL FAN.

In response to a personal letter from the editor regarding the Capell fan, erected at the Youghiogheny Coal Co's. No. 1 Mine, Scott Haven Pa. Mr. W. S. Gresley, General Manager of the company, writes as follows:—

Scott Haven, Pa., Aug. 26, 1895.

"Regarding our Capell fan at our No. 1 Mine, I would say: It is a single 8 ft. fan. It runs at about 208 revolutions per minute (exhausting), and at 1 in. W. G. it is passing about 85,000 cu. ft. of air per minute through the mine. The air traverses about 2 miles of entries and workings before arriving at the fan. This fan was guaranteed by Mr. Clifford to pass 65,000 cu. ft. at 325 revolutions, and you see we get 20,000 cu. ft. more than the guarantee at ⅔ speed. We are driving the fan with a General Electric Co's, 25 H. P. 500 volt multipolar motor, belt connected, and the entire outfit is giving great satisfaction. I have known the Capell fan for about nine years and can honestly and very strongly recommend it. It is, I think, especially adapted to comparatively high speed motors. We are now putting in 2 more of these fans, one an 8 ft. same as No. 1 Mine fan, and the other a 12½ ft.—also single inlet machine. Both of these fans are intended to be operated by electric motors, the smaller one being close upon 3 miles away from the generating or central station.

"Mr. Clifford is also building me, for No. 1 Shaft at Spring Valley, Illinois, a 12½ ft. Capell fan, to force air through the very extensive longwall workings under high water gauges. This fan however is being constructed to exhaust instead of blow, when necessary.

"Mr. Clifford's fans are the strongest built machines of the kind I ever saw.

Very truly yours,

W. S. GRESLEY,

Gen. Mngr. Youghiogheny River Coal Company, and Con. Mining Engineer, Spring Valley Coal Co., Ill."

Mr. Wm. Clifford, M. E., Westinghouse Building, Pittsburgh, Pa., is the sole licensee and manufacturer of Capell fans in America. There have been so-called Capell fans erected in this country in the past, which while equal to the duty they were called on to perform, were not an unqualified success, as they were not constructed exactly on Dr. Capell's lines. They were purposely made different in several essential points so as not to infringe on the Capell patents. As a result the excellent results obtained at Scott Haven were not obtained with the so-called Capell fans.

MISCELLANEOUS.

LIVING AND LEARNING IN OLDEN TIMES.

A man, who spoke from experience, thus discribes the manner of students living 40 years ago. He began his experience at Williston Seminary. He said: "The students worked as hard and fared as cheaply as the men and women employed in the big factory of the place, and I know that I pored over my books of Greek, Latin, and mathematics for for hours of the night after the factory people were asleep.

"Our seminary fees were not more than $20 a term, and the payment was not required in the case of a student who confessed inability to meet them, while President Clark was especially gracious to such a student, of whose impecuniosity no one else was ever made aware. The rent of my room in the seminary was, if I remember correctly, $1 a month; and every room was good enough for its purpose. As for the price of table board in the houses in which the students boarded, it ranged from $1.25 a week up to perhaps twice that amount, for all I know. I paid $1.25 a week for victuals thrice a day. A lot of us formed ourselves into a club, one of the members of which went out into the town and negotiated for rates of payment with some housekeeper of economical mind who could accommodate perhaps twenty or thirty of us at a long table in her house. There were other clubs at which the prices were higher than at ours; but we were the Spartans, and did not care for that. Plenty of the students boarded at the houses of factory workers, whose wives prepared the meals. As for the dearer places, I doubt if there was any of them at which the charge was over $3 a week. At our club we had enough of that nourishing provender which is the very best thing for young students who mean to apply their whole mind to their studies without distractions. We had good mush, with maple molasses; we had corn bread and milk; we had fish; we had hash, and other things. Every day of the week we had a change; and Sunday was the best day of the week. There was not a scrap of waste at our table in our club, which was for those of the students who had no coin to waste. I remember how proud we were of our scholastic poverty.

"I am sure that the cost for me of living and learning at Williston Seminary, in Massachusetts, forty years ago, was less than $100 a year, and I earned that sum by my work during vacation. It was far easier then than it is now for a young man of narrow means to get a classical education. The training at the seminary was of the very best kind and fitted a student for any college.

"As it was necessary for me to count my dollars after I left the seminary, I visited both Yale and Amherst for the purpose of finding out the cost of living and learning at each of these collegiate institutions. The cost at Yale was less than half as much as it is now; but that at Amherst was yet less. I found I could get as good board for $2 a week when there as I had got for $1.25 a week when at the seminary; and I found that the tuition fees were within my narrow means. Everything there then was for the sons of ordinary folks, and I was told by Prof. Tyler that plenty of the students earned during the months of vacation a part, if not all, the money which they needed for college expenses. Forty years ago Amherst was a good place for an aspiring youth not overburdened with filthy lucre who wanted to get a classical education; and it had a faculty the members of which encouraged a student of that kind. One of the very best of the professors there then was Dr. Edward Hitchcock, the distinguished American geologist.

"I think it is to be regretted that the cheap old times at our American educational institutions have departed, and that the chances for the poor young aspirant are not as good as they used to be. The amount it would cost one of my sons to go through seminary and college in these days would be at least twice or thrice the amount it cost me. When I told my oldest boy about my expenditures as a student, and how I earned them, and how I studied day and night, he smiled.

"I read in *Macmillan's Magazine* a while ago an account of the meagre living of many of the students at the old Scotch universities forty or fifty years ago, when the writer of the article was a freshman at one of them. He told of farmers' boys trudging afoot over the mountains from their homes to the college, carrying on their backs a sack of oatmeal, out of which they would make their own porridge for a month or longer, till they went home and got another sack, besides, perhaps, a string of red herrings. Ashamed of their poverty? Not a bit. They were going to be great scholars, and the thought of that made the porridge and buttermilk the pride of their life. It was learning they were after, and happy they were to cultivate on oatmeal. I did not suffer any such pressure in my college years in Massachusetts, but the reading of that essay in *Macmillan's Magazine* brought back those happy years to my mind and taught me that even our board at $1.25 a week at Williston Seminary was living fit for a lord."—*N. Y. Sun.*

THE USEFUL MICROBES.

There has been so much written for some time past about the microbes of disease that, to most persons, the very name of microbe suggests poison, pestilence and death. It is therefore well to notice that these dreaded organisms are just as closely connected to the means of protecting health, and that, upon the principle of the old adage "set a thief to catch a thief," they furnish the most efficient means of combatting all sorts of infections as well as being the foundations of many valuable processes such as bread making and brewing. Some experiments have recently been made in England with large filters for filtering the sewage of cities, in which it has been conclusively shown that to make such operations a success, the microbe is indispensable and must be treated with most distinguished consideration. In the first experiment a filter, made of coke breeze, an acre in extent, was used, and the sewage allowed to run continually through it. In less than three months it clogged and became putrid.

In the second experiment the filter was merely filled and emptied twice daily, with such satisfactory results that fish placed in the filtrate were kept alive many weeks. A published report of these experiments states: "The conclusions arrived at in regard to these experiments are of considerable importance from a practical standpoint. 'The action of a filter is two-fold. In the first place, it separates mechanically all gross particles of suspended matter and thereby renders the effluent clear and bright. But the second consideration is the more striking. It is the action of the filter in effecting the oxidation of organic matters, both those in suspension and those in solution, through the agency of living organisms. It is the preliminary establishment and subsequent cultivation of these organisms which is to be aimed at in the scientific process of purification by filtration. The ordinary putrefactive and other similar organisms commence the work by breaking down the organic compounds and converting them into less complex forms—principally water, carbonic acid, and ammonia.

"The nitrifying organism then acts upon the ammonia, the nitrogen being converted into nitric acid. For this process to go on, three conditions are declared to be essential. First, the organisms must be supplied with plenty of air; secondly, there must be present a base—such as lime—with which the nitric acid can combine; and thirdly, the biological action must take place in the dark." Filtration on biological lines is further explained, followed by the statement that "the life of a coke filter worked in the manner is practically without a limit." We are assured that "there is no difficulty in obtaining any desired degree of purification by means of a system of filtration conducted on biological principles." One single sentence places the whole subject in a very different light from that which has generally appertained to it. The announcement is made that by the system now propounded, and already exemplified, "the necessity for costly farms is entirely obviated."

The experiments made in this country at Lawrence, by the Massachusetts State Board of Health, give similar results with sand filters, and show that purification by precipitation and filtration solves question of sewerage disposal by large cities.

These experiments show how by the use of the microbes on a large scale one of the most difficult problems in sanitary engineering may be accomplished which would be very costly if not impossible without them. This is only one example however, and it is probable that on the whole we receive more of good from the microbes than of harm, and those nervous people to whom these useful organisms are such a terror should take courage and learn to cultivate those that are of use, and remember in regard to those that are harmful, that

> "Fleas have other fleas to bite 'em,
> And so on ad infinitum,"

and that microbes are no exception to this rule.

ARABIA AND ITS PEOPLE.

Arabia comprises a wide region, which in its southern and central portions abounds with tracts of quite fertile country, extending inwards to a great table-land, which can also sustain a large population, and which possesses one of the healthiest climates in the world. It is fringed, however, all around its long coasts with stretches of sand, which at irregular intervals pass deep inland, until the great Dahna, or desert, is reached, which separates the fertile southern district of Yemen, the ancient Sheba, from the table-land, above mentioned, of the Nejd. Then to the north mountainous and stony deserts, with other stretches of sand, and occasionally fine oases here and there, extend likewise far to the east over to the valley of the Euphrates. This extensive country, therefore, has always afforded opportunities for settlements, with large towns and rich productions, separated, however, by open, treeless, and often rugged wastes, where none but nomads can live. A natural result of such a combination of physical elements has been that its people have been divided up into numerous distinct communities, inhabiting cities, with both trade and agriculture, while between them have roamed great numbers of tent-dwelling tribes, who, besides living on their flocks and herds, have always regarded it as their hereditary privilege to raid the caravans of the city dwellers. Moreover, the cities have never been really united under one government, but are from their position inclined to an independence and jealousy of each other, which, likely as it is from their physical conditions, yet for Arabs is well-nigh inevitable under all circumstances. Real Arabs are congenitally disposed to disagree. One of their famed poets, Ibn el Werdi, says, "No man can fail to have his enemy, though he should try living on a mountain-top." Another, El Tugraki, equally distinguished, uttered words often quoted both for their beautiful rhyme in the original and for their sentiment: "Love of peace takes all the life out of a man. If you incline thereto, set up a ladder to heaven and scramble thence, or find where you can mope in some underground cellar." The Arab disposition in fact is at bottom not unlike their great national animal the camel's. When you bid a camel to get up he objects, when you order him to start he objects, and when you order him to halt he again objects, showing that he really objects on principle.

As might be expected, these national traits show themselves in that faithful mirror of a people's true life, its language. A richer language does not exist for the names of external objects in nature, showing that its people are the children of the open air as no other race is. There is a quaintness and vivacity of expression in it which no other tongue can excel, and in its grammatical structure it can be made the vehicle of the most compressed utterance that can be imagined. But when the words are put to use you are struck with the inexhaustible richness of idioms expressive of a taunting, sarcastic, ironical, and mocking nature. That was a true Arab's answer which Job gave to his lecturing friends: "No doubt but ye are the people, and wisdom shall die with you!" So the Bedouin when he meet a stranger in the desert addresses his hapless victim, "My dear nephew, your aunt [*i. e.*, my wife] wants your garment, for her aged limbs are cold." When an Arab wishes to express dissatisfaction with you, he simply says, "*Subhan Allah*"—"God is to be glorified"—but the verb is in the Arabic subjunctive, and hence means that God is to be glorified although—The ellipsis to be supplied, of course, is, although He made you! So when a man returns from a journey his friends meet him with the salutation, "*El hamdulillah bis selame*,"—"Praise to God, we see your face in peace." But often the same greeting awaits a servant who has been too long on an errand.—*From "Arabia—Islam and the Eastern Question," by Dr. William H. Thomson, in Harper's Magazine for September.*

COMMERCIAL PRODUCTS FROM ACETYLENE.

It occasionally happens that the easy synthesis of one chemical compound will unlock the door to the cheap commercial production of a room full of others. It is declared that calcium carbide (with water power to run the dynamos) may be made for less than twenty dollars per ton. Now, from one ton of calcium we may obtain 812 pounds of acetylene gas, costing less than two cents and a half per pound. This means with certainty, the cheaper manufacture of innumerable substances used in the arts which may be made from acetylene by processes which, up to this time, have been matters of pure chemistry, but which, on account of the lessened cost of acetylene, will now wage war with the older methods.

Acetylene, on being passed through an iron tube heated to dull redness, goes rapidly and completely into benzine, without the formation of any other product. Benzine is a product of prime importance, and is the base of thousands of organic substances, known as the benzine series of compounds. If the resulting benzine vapor be passed into strong nitric acid it is transformed into the oily nitro-benzine, and this, on treatment with hydrochloric acid and iron filings, goes easily into aniline. The ton of calcium carbide, or the 812 pounds of acetylene, results thus in somewhat less than 956 pounds of aniline. With the formation of aniline the road is now clear for the production of the innumerable dye substances whose varied hues have adorned the sisters and wives of the last twenty years, and whose discovery and preparation absorb the energies of an army of chemists.

Instead of passing into the dye substances, however, we may transform our aniline into carbolic acid. Thence it is but a step to picric acid, the foundation substance of many modern explosives. Or again, we may boil the aniline with acetic acid and we have transformed it into acetanilide or anti-febrin, the well known fever specific.

Our protean acetylene, however, is capable of undergoing other changes just as startling. For instance, if it be passed through a tube heated to bright redness, it is changed to naphthalene, and naphthalene again will pass into a multitude of other valuable products. Or again, starting with acetylene, by the action of nascent hydrogen, we may change it into ethylene and finally into ethane. Ethylene, on being boiled with sulphuric acid and water successively passes into alcohol, which is absolutely necessary to the production of an enormous number of economic substances. Ethylene on treatment with permanganate of potash readily oxidizes, first into oxalic acid, and then into formic acid. If the formic acid so obtained be treated with ammonia, and the resulting product heated to 180 degrees C., it is transformed into the deadly prussic acid. Acetylene in the mere presence of salts of mercury unites readily with the elements of water to form aldehyde, so much used to-day in the production of essences and the manufacture of mirrors.

Starting with acetylene, by the agency of such cheap commercial products as muriatic acid, sulphuric acid, potash, ammonia, and a few others, it is possible to build up whole systems of dyes, medicines, essences, perfumes, poisons and explosives. The methods by which this may be accomplished are known matters of pure chemistry. They become commercially and economically practicable with the cheap synthesis of acetylene. Since this has been accomplished by the aid of the electric furnace and a mixture of lime and coal, we may expect to see the influence of acetylene ramifying throughout all organic chemistry. It has a utility out of all proportion greater than that derived from its peculiar light-giving powers.—*R. K. Duncan in Electrical Engineer.*

AMONG THE BASKET MAKERS.

In the stony valleys among the hills of Connecticut, where the bowlders lie too thickly for the plowman ever to disturb the soil, one will occasionally run across a little hamlet, where the basket makers spend their quiet but useful lives. It would seem that it must be a poor and barren part of New England that cannot be turned to some account. In these little communities the craft of basket making has passed from father to son for many generations, and doubtless will for many more, for, in spite of modern invention, the good white-oak basket promises to be as much in demand in the 20th century as now. Sheet iron or aluminum, paper or tropical fibre may do some part in solving the basket problem of the future, but alongside of these modern makeshifts will be found the tough products of the almost irreclaimable stony forests of the mountain regions.

Sometimes there will be a large, rude shop, surrounded by one-story gray cottages of the basket makers. In the shop they will carry on work in common, saving expense for fuel in winter. Other families will have a shop by themselves. Outside the door one will see frequently a pair of oxen hitched to a heavy wood sled with a load of basket timber, logs cut about nine feet in length. On the walls inside one sees an assortment of drawing knives, some of them polished, worn and ground down to a narrow strip of steel, ready to break after many years of use. There are wooden bench vises where the men sit to shave off the splints, and overhead one will see rows of bent white hickory handles, looking like rows of horseshoes in a blacksmith's shop.

No little skill is required to split up the wood so as to waste scarcely any, to shave out the tough, upright strips and to bend them into proper shape, to split out the "filling" and deftly weave it in. The black oak is fortunately so put together by nature that when a split stick of it is skilfully hammered across a large flat stone the different layers made by each year's growth will separate and lie all ready for the basket makers to use. White oak, black oak, pin oak, hickory, white walnut, pignut, white ash and black ash all enter into basket making more or less but white oak is the standard wood.

The basket makers who prepare their own material look with contempt on the baskets made in factories, where the splints are cut out by machinery. The machine necessarily often cuts across the grain of the wood, causing a weak place in the basket. The factory baskets are much cheaper, or course. One can buy a bushel basket of this kind for 35 cents when a hand-made basket, strengthened and bound with hoop iron, may cost $2, yet one of the latter will outwear 10 of the former; the one may weigh five pounds, the other 10 to 12. Sometimes an order will come for a big wool basket, to hold 12 to 25 bushels, or a dealer may want a few hundred of the conical bushel baskets used by the market gardeners of Long Island and New Jersey. The favorite basket for picking apples is the round half bushel with hickory bale, as it fits in nicely between the rungs of a ladder.

It is an exciting day in the basket village when one of the big rick wagons is loaded up with baskets to go to the steamboat landing or railroad station. There may be consignments in it from half a dozen families to half a dozen dealers. And there follows an interesting suspense as the wagon rolls out of sight till the check comes back from the New York merchant through the mail.

If the basket makers could always have steady work they could accumulate snug little fortunes, but the trade is a precarious one, and its followers generally make only a bare living. However, one will find the people hospitable and kindly. Although hands may become callous in wrestling with hickory and hoop iron, the workingmen's hearts are as open as any. There is no more cheerful blaze than that made in a shop stove out of hickory shavings, and your hosts are not only generally glad to welcome a visitor, warm him and chat with him, but will, if he likes, give him a big armful of shavings to start his own fire.—*New York Tribune.*

OAT MEAL DRINK.

Those who work in hot places must drink large amounts of water. This is especially true of the firemen on the steamboats that ply the waters of our rivers, lakes and oceans. The drinking of clear water under these circumstances appears not to answer the wants of the system. It passes through the circulation of the skin, as through a seive, and flows over the surface of the body in streams. A large drink of cold or even cool water, under these circumstances on an empty stomach is very dangerous and may produce death. Great practical advantage has been obtained by mixing farinaceous substances, particularly oatmeal, with the water to be used by the men employed at this labor.

The oatmeal is mixed in the proportion of a quarter of a pound to the gallon of water, and used according to inclination by the firemen and coal-heavers. It would be difficult to determine why oatmeal, for this purpose, should be better than corn meal, buck-wheat, rye, wheat, millet, etc., but the firemen seem to think it has the effect of making them strong. We may safely allow something for this sort of prejudice, which we know to be very potent among the influences on health and disease. The peculiar odor of the oats is associated with a pleasant degree of stimulation of the alimentary mucous surfaces, in such a way as to promote its complete digestion. It seems to fill the blood vessel without increasing the amount of cutaneous exhalations. The men occasionally try acid, saccharine and alcoholic drinks as substitutes but always with unsatisfactory results, except that they find molasses and water better than clear water, and those who are disposed to insist on the excellence of rum and whiskey under all circumstances, petition for these, and experience a momentary relief, followed by additional profuseness of perspiration and additional exhaustion.

The attoley of our Indians is a nutritive beverage similar to oatmeal drink used principally at the South and throughout Mexico. It is made by parching their corn (maize) or other grain, pounding it to meal in a suitable cavity of rock, with a smooth stone, and mixing it with a little sugar if they have it. About a tablespoonful of this is stirred with a pint of water from the spring and swallowed at two or three drinks, according to inclination. An Indian, provided with about two pounds of attoley in a little bag, is prepared to perform the most fatiguing and dangerous journey of two or three weeks, without expecting assistance or supplies by the way except water from the spring or brook twice a day. He appropriates, of course, any little food which comes in his way, but when this amounts to next to nothing he comes out of such an expedition without much apparent suffering or inconvenience. Nearly any other grain or grass seed seems to answer the purpose, though the Indian corn is generally preferred. A very small quantity of food, fully digested and assimilated, is capable of supplying the waste of the system even through extraordinary labor and fatigue.—*Dr. Joseph Wilson, in the Journal of Hygiene.*

THE PEDANTRY OF SPECIALISTS.

Of coining many words in the scientific world there has of late years been no end. This is the age of specialists, and of particular, accurate, and even hair-splitting knowledge. And of course refinement of knowledge must be crystalized in diversified nomenclatures. Sometimes, it is true, it has seemed as if the terminologies were likely to outstrip the knowledge, names being fairly spawned on the world in certain departments of science without corresponding increase of actual discoveries. To conservative persons it has seemed as if the word forming habit has become almost a disease in certain circles, and more than one protest has been lodged against allowing this scientific logomania to become epidemic.

It would seem, however, that there are certain departments of research where the opposite fault of undue abstemiousness in the coining of names is to be observed. In a recent number of the *Auk*, Mr. William T. Hornaday, the famous taxidermist, lodges a complaint of this kind against American naturalists. The particular sin of omission against which he protests is the failure of working naturalists to supply newly discovered animals with English names. It appears that in the last decade something like three hundred new species and sub-species of mammals have been discovered in this country. Each one of these has been at once supplied with a Latinized name long enough to more or less nearly approximate the length of the animal itself, but about half of them have been given no English name whatever. The result is that for all but the select few of the inner circle of naturalists these animals are practically nameless.

Mr. Hornaday urges that this is all wrong. He calls attention to the very pertinent fact that unscientific persons for the most part furnish the money with which scientific researches are carried on—with which, for example, museums are founded and developed—and thinks that for this reason, if no other, the untechnical masses are entitled to some consideration at the hands of the technologists. He urges the naturalists, therefore, to make amends for their shortcomings, and christen the neglected animals.

There is certainly a large mass of intelligent readers who will feel that Mr. Hornaday's protest is timely and important, and who would go a step further, and request that naturalists not only supply English names for animals, but that they also use these names in referring to the animals. All technical publications fall more or less commonly under the eye of untechnical readers, who would like to glean something from them, but who are often repulsed by finding only Latin names, so that they are unable to readily discover whether the creature they are reading about is a beast, bird, or fish.—*From Harper's Weekly.*

THE ART OF BREATHING.

It is perhaps one of the signs of the times, to those alert for indications, that the art of breathing has become more and more a subject of attention. Oculists as well as physiologists go deeply into its study in a way hardly to be touched upon here. Physicians have cured aggravated cases of insomnia by long-drawn regular breaths, fever-striken patients have been quieted, stubborn forms of indigestion made to disappear. A tendency to consumption may be entirely overcome, as some authority has within the last few years clearly demonstrated, by exercises in breathing. Seasickness, too, may be surmounted, and the victim of hypnotic influence taught to withstand the force of any energy directed against him.

There is a famous physician of Munich, who has written an extensive work upon the subject of breathing. He has, besides, formulated a system by which asthmatic patients are made to walk without losing breath, while sufferers from weaknesses of the heart are cured. At Meran, in the Austrian Tyrol, his patients (almost every royal house of Europe is represented) are put through a certain system of breathing and walking. The mountain paths are all marked off with stakes of different colors, each indicating the number of minutes in which a patient must walk the given distance, the breathing and walking being in time together. As the cure progresses the ascents are made steeper and steeper.—*From Harper's Bazar.*

ONTARIO'S MOVING HILLS.

An interesting and wonderful feature of the natural scenery of Lake Erie shores are two immense conically shaped sand formations, in the township of Houghton, Norfolk county, Ontario, just west of Long Point.

These hills are composed of the light silvery sand peculiar to the shores of the lake, with the one dissimilarity, that it appears lighter in bulk than the shore sand and drifts more readily with the wind. They are situated about a mile apart, the one to the east being the larger. It measures about 200 feet in height from the water level, 1,000 feet in length, and 300 feet in width. When viewed from the surrounding country it appears like a vast symmetrically formed giant's grave, erected on the lofty promontory, which lies high above and whose precipitous cliffs wall in the lake for miles.

These hills, besides their present interest, have a strange evolutionary history ascribed to them, as recorded by some of the early settlers in the vicinity. At one time the summit of the large hill presented a circular plateau with a crater opening into a vast funnel-shaped chasm, with sides nearly vertical, which extended down to a great depth. The bottom of this great amphitheater was eighty feet in diameter, and upon this natural arena the pioneer youths of many years ago played the game of baseball with the advantage of requiring no fielders, for, no matter where the ball was thrown or batted, upon striking the sides it would fall to the feet of e players. No trace whatever is now left of the crater. Many are the forms the hill has assumed since then.

If it is the action of the strong southwesterly gales, which for 150 miles have an uninterrupted swoop down the lake, upon the loose sand of the cliff, why are other hills not thus formed by the same force all along the shore in this locality, where the sand appears the same as here? There is a sand mound close to the large hill nearly forty feet high, which has the appearance of growing similar to the others. It is enclosed on three sides with a thick growth of large trees which it is gradually covering up.

These hills slowly but really change their positions, ever retaining some graceful and strange shape. The old trees that form a dense growth near by are gradually swept over and completely buried in sand. In many places their utmost branches only protrude above the surface of the sides of the ruthless sand monster that smothered and settled upon them. In time, as the hill moves on, these trees are again revealed, broken and dead, of course, with whitened trunks and maimed limbs.

Some twenty years ago the summit of the large hill was crowned by the observatory of the United States Lake Survey. From the observatory, one in the highlands of Pennsylvania, and another on Long Point, a triangle was formed, and the most accurate chart of the lake at that time was issued. At present a beacon is the only structure on the hill, having been erected in connection with the survey now being made of the lake by the Canadian Government.—*From the Buffalo Express.*

TISSUE STARVATION.

Strictly speaking, starvation is "an insufficient supply of the nutrition which is necessary for the proper support of the body." In the light of this definition it becomes evident at once that there is a condition of bodily famine which is not due to financial stringencies, and which is outside the pale of charity, since it belongs to the category of disease.

Man has a very complex nature, of which it is necessary to meet the requirements as exactly as possible if its different parts are to work harmoniously and in perfect health.

For instance, the disease which sometimes attacks children in their infancy, and which is perhaps better known as marasmus than by any other name, is a lack of nutrition, or a mal-nutrition pure and simple. Food, no matter how rich in nutrients, is useless if the system is unable to draw out these nutrients on their way through the digestive canal. A marasmic baby dies from starvation as surely as though he had suffered the sharpest pangs of hunger.

Rickets is another condition due to systemic starvation, and is closely allied to the preceding. The patient is unable to assimilate, or take into the system for its nourishment, the particles of fat in food.

Many diseases, more especially those of a "germ" origin, feed upon the tissues of the body. In these instances a greater part of the food taken into the body is seized upon by the disease or germ for its own nourishment. This process is called pathological starvation, or starvation due to disease. The various tuberculous conditions are examples.

Extremes of cold or heat also interfere with the nutrition of the body, cold by lowering the vitality of the body, and heat by raising the combustion of food to such a point that the demand is greater than the supply.

The direct result of systemic starvation is of course a lowering of vitality, by which the body becomes not only less able to perform the work required of it, but is more or less open to the ravages of disease of every form.

Many nervous disturbances and diseases, like nervous prostration, can be traced directly to a disturbance of nutrition. Indeed, it is doubtful if a condition of nervous weakness is not synonymous with tissue starvation.—*Youth's Companion.*

A CHILD'S GENIUS FOR ASKING QUESTIONS.

Child instruction should in the first instance proceed upon the principle that the young mind is an incalculable possibility, and that schooling should be of a character to carry that possibility just as far as may be toward its realization. The child's mind is as thickly studded with interrogation points as the sky is with stars. The primary genius of a child is the genius for asking questions. There is a natural affinity between the mind and the truth. Inquisitiveness is as natural to intelligence as hunger is to the stomach. One of the most common effects of current schooling is to destroy that affinity. Intellectual stuffing in the nursery or in the schoolroom is worse and more wicked than gluttony in the dining-room. Children who commence going to school when they are six and continue at it till they are sixteen hate knowledge a good deal worse than they do sin, and if they had the courage of their impulses would assassinate their instructors and practice nihilism on their schoolrooms and text-books. The distinct symptoms of nihilism are discernible in every schoolroom that has been used for educational purposes more than six months. This intellectual demoritization of the schoolroom will pursue its present course till teachers are selected who have enough of the genius of Froebel to understand that the mental constitution of the child is itself prescriptive of the course to be followed in its development, and that the proper office of school commissioners and school committees is to help the teacher to carry out the intentions of nature rather than to compel him to embarrass and controvert those intentions.—*Rev. Charles H. Parkhurst, D. D., in Ladies' Home Journal.*

THE FIRST COWBOYS.

The cow-puncher's play-ground in those first glorious days of his prosperity included battle and murder and sudden death as every-day matters. From 1865 to 1878 in Texas he fought his way with knife and gun, and any hour of the twenty-four might see him flattened behind the rocks among the whiz of bullets and the flight of arrows, or dragged bloody and folded together from some adobe hovel. Seventy-five dollars a month and absolute health and strength were his wages; and when the news of all this excellence drifted from Texas eastward, they came in shoals—Saxon boys of picked courage (none but plucky ones could survive) from South and North, from every town and country. Every sort and degree of home tradition came with them from their far birthplaces. Some had known the evening hymn at one time, others could remember no parent or teacher earlier than the street; some spoke with the gentle accent of Virginia, others in the dialect of baked beans and codfish; here and there was the baccalaureate, already beginning to forget his Greek alphabet, but still able to repeat the two notable words with which Xenophon always marches upon the next stage of his journey. Hither to the cattle country they flocked from forty kinds of home, each bringing a deadly weapon.

And then, the same stress of shifting for self, the same vigorous habits of life, were forced upon each one: watching for Indians, guarding huge herds at night, chasing cattle, wild as deer, over rocks and counties, sleeping in the dust and waking in the snow, cooking in the open, swimming the swollen rivers. Such gymnasium for mind and body develops a like pattern in the unlike. Thus, late in the nineteenth century, was the race once again subjected to battles and darkness, rain and shine, to the fierceness and generosity of the desert. Destiny tried her latest experiment upon the Saxon, and plucking him from the library, the haystack and the gutter, set him upon his horse; then it was that face to face with the eternal simplicity of death, his modern guise fell away and showed once again the medieval man. It was no new type, no product of the frontier, but just the original kernel of the nut with the shell broken.—*From "The Evolution of the Cow-Puncher," by Owen Wister, in Harper's Magazine for September.*

HOW MINERAL WOOL IS MADE.

Of those who know what mineral wool is, or silicate cotton, as it is sometimes called, probably only a small number are familiar with the simple process by which it is made. The wool itself, serving a variety of useful purposes, as a non-conducting covering against heat and cold alike, for steam pipes and cold storage room walls, as a sound "deadener" in floors of buildings and as a means of fireproofing, among many others, is, as its name implies a soft and woolly substance, consisting of a mass of very fine mineral fibers interlacing one another in every direction, and thus forming an endless number of minute air cells. The wool appears on the market in a variety of colors, principally white, but often yellow or gray, and occasionally quite dark, and is made by converting scorial and certain rocks while in a molten state into a fibrous condition by a steam blast directed against the liquid material. Blast furnace slag forms the raw material for one variety of the wool, and sandstone for another, yielding, respectively, slag wool and rock wool, the latter being preferable for pipe covering because of the absence from it of sulphur, which, with moisture present, bebecomes an active corroding agent. The furnace slag or the rock, as the case may be, is melted in a large cupola, and as it trickles out at the tap hole in a somewhat sluggish stream it meets a high-pressure steam jet which atomizes the woolen mineral, if it may be so termed, blowing it in fleecy clouds into the storage room provided for it. Soft and downy, the stuff settles wherever a resting place affords itself, the heavier and coarser wool coming down first, while the lighter portions are blown further along by the force of the steam and settle in the more distant parts of the room, the material thus naturally grading itself into varieties of different quality. A thousands pounds of wool per hour are turned out by one of the cupolas, and after the storage room has been blown full the flocculent mass is pushed into bags, ready for the market. The whole process affords an admirable and interesting illustration of the utilization of an utterly waste product.—*Cassier's Magazine* for September.

NO BOOK TYPOGRAPHICALLY CORRECT.

I remember once of a publisher in London who made up his mind to publish a book that should have no typographical errors whatever. He had his proofs corrected by his own proof-readers, until they all assured him that there were no longer any errors in the text. Then he sent proofs to the universities and to other publishing houses offering a prize of several pounds sterling in cash for every typographical mistake that could be found. Hundreds of proofs were sent out in this way, and many skilled proof-readers examined the pages in the hope of earning a prize. A few errors were discovered. Then all the proof-sheets having been heard from, the publisher felt assured that his book would appear before the public an absolutely perfect piece of composition. He had the plate cast, the edition printed and bound between expensive covers—because as a perfect specimen of the printers' art it was of course unique in literature, and exceedingly valuable to bibliophiles. The edition sold well and was spread all over the country. The publisher was very much pleased with himself for having done something that had hitherto been considered an impossibility. Then his pride had a fall, for six or eight months later he received a letter calling his attention to an error in a certain line on a certain page. Then came another letter announcing the discovery of a second error in this perfect book. I believe before the year was up four or five mistakes were found.—*From Harper's Round Table.*

THE MOON AND THE WEATHER.

In an address of more than usual interest, delivered at the the Meteorological Society by Mr. Richard Inwards, the president, the numerous fallacies which prevail with respect to the weather were exposed. The moon is very generally supposed to have a direct influence upon the weather; but, as Mr. Inwards shows, the influence is merely suppositious. As long ago as 1774, Dr. Horsley examined the weather tables of that year as furnished by the Royal Society, and out of 46 changes of weather only ten occurred on days of lunar influence, only two of them being at the new moon, and none at all at the full. As a result of twenty year's observation, M. Flarguergues, of Viviers, found that the barometer readings taken when the moon was farthest from the earth averaged 755 millimeters, and when nearest, 754 millimeters, showing a difference of 1 millimeter, or .04 inch, and this in a direction against the theory, the pressure being greater by that amount when the moon was farthest from the earth. The cycle theory, such as that advocated by Mr. MacKenzie and more recently by Mr. Hugh Clements, has, we are told, broken down, and there is no definite period after which the weather changes repeat themselves. The moon's influence on the weather is negligible, M. Flammarion, tells us, and the ideas that the full moon clears away clouds, that beans should not be sown or trees cut down on the wane of the moon, that two full moons in a month will cause a flood, or that to see the old moon in the arms of the new one brings rain, are all, to use an expressive phrase, mere moonshine. They are not only not supported by scientific observation, but are opposed to observed facts. The heat reaching us from the moon would only affect our temperature by 12 millionths of a degree, and the atmospheric tides caused by the moon would only affect the barometric pressure by a few hundredths of an inch—a quantity far less than the changes which are always taking place from other causes. Even the influence of the halo round the moon has been discredited, for observation shows that it is as often followed by fine weather as by rain. Altogether, the influence of the moon may be summed up in the words of the old rhyme—

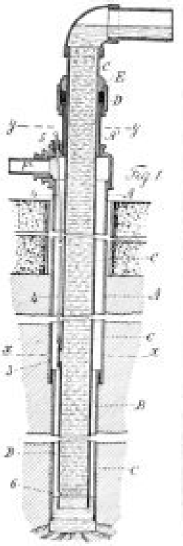
The moon and the weather
May change together;
But change of moon
Does not change the weather.

Newcastle, Eng. Chronicle.

NEW INVENTIONS

PNEUMATIC WATER ELEVATOR.

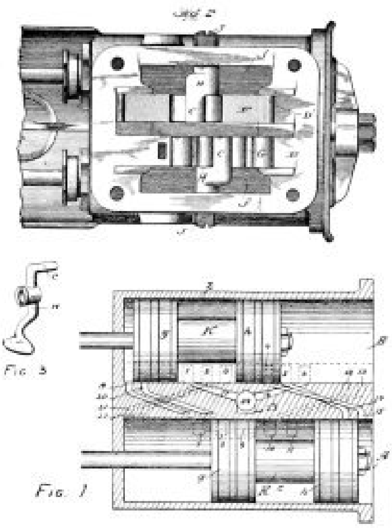
No. 542,620. James E. Bacon, Richmond, Va. *Patented July 16, 1895.* This apparatus operates upon the principle that a column of mixed air and water, is lighter than a column of solid water, in proportion to the amount of air bubbles contained in the mixture. The rising pipe *C* extends nearly to the bottom of the well, and is perforated with holes 6, a few inches above the end. The casing is closed at the top and is provided with a stuffing box *D*, through which the pipe *C* passes. Compressed air is admitted through the pipe *F*, to the space between the casing and the pipe *C*. It drives the water down to the level of the holes 6, and then escapes up the pipe in the form of bubbles. The air pressure has only to lift the water above the level to which it would naturally rise in the well. The space between the casing and pipe *C* forms an air reservoir of sufficient capacity, so that the compressor may be connected directly to the pipe *F*, and no other reservoir is needed. The air passing in at the lower



part of the uptake-pipe is usually sufficient in volume to lighten the column; but with deep wells or with considerable lift for the water above the water level in the well, it is sometimes advantageous to employ an auxiliary lift by providing a second air-supply higher up in the uptake pipe to still further lessen the weight of the column of liquid. To effect this object the slide-valve 3 may be provided over an opening in the uptake-pipe at any desired level, and a rod 4 extending from this valve up through a stuffing-box 5 allows it to be opened by hand more or less, and thus to admit the volume of air required for operating the auxiliary lift to the best advantage.

DUPLEX STEAM PUMP

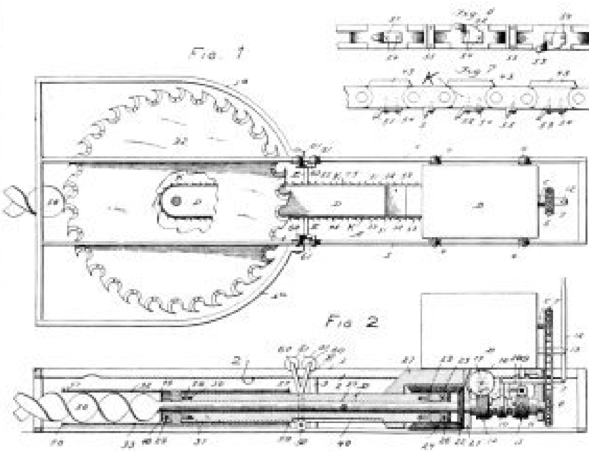
No. 542,342. Cassius M. and Edgar E. Miller, Canton, Ohio. *Patented July 9th, 1895.* Fig. 1 is a horizontal section through the cylinders; Fig. 2 is a top view showing the steam valves; and Fig. 3 is a perspective view of the lever which is used to move the valves. Each piston is double headed



as shown, and the enlarged end of the levers *H* play between these heads. The steam chest contains two slide valves *F* and *G*; *F* serving the cylinder *A*, and *G* controlling the cylinder *B*. The ports necessary to conduct the steam to the cylinders cross each other as shown in Fig. 1. The valves are moved by means of the arms *C* on the upper end of the levers *H*, which are pivoted upon the pins *J*. Thus the piston in cylinder *A* operates the valve *G* which controls the admission of steam to *B*, and the piston in *B* moves the valve *F* which controls the supply of steam to cylinder *A*.

MINING MACHINE.

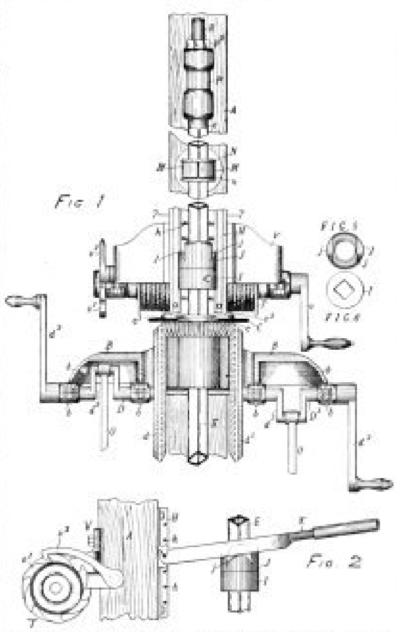
No. 544,424. Joseph L. Beury and John T. Cressey, Beury, W. Va. *Patented Aug. 13th, 1895.* Fig. 1 is a top view of the machine; Fig. 2 is a lengthways vertical section; Figs. 6 and 7 are side and top views of the center cutting chain. The cutting is done principally by two circular saws 32 and 33, which run in opposite directions. The saws are rotated by means of the chains *K* which connect the sprocket wheels 28, 29 to the drivers 25, 26. These are driven in opposite directions by means of the bevel gears 22, 23, 24. Power is furnished by a motor *B*, through the sprockets 5, 6, and chain 7. The machine is moved forward and back by means of the right and left worms 14, 15, the gears 17, 18, and small pinions which engage the racks 2, upon the under side of the frame bars 1. The saws are mounted in the end of the beam *D*, which is supported by a truck *E*, running upon the frame 1. The space between the saws is made large, so that the coal which is broken out from between them is of marketable size, and is not wasted by being ground into slack. The slab of coal which is left standing between the two saws, is divided by means of the auger 56, and is thus



made easy of removal. The chains *K*, which are armed with suitable cutters, enter the auger hole and carve a passage way for the beam *D*. When the slab between the saw cuts is removed, the hole thus formed is so large, that the hanging coal will be properly thrown forward when shot down.

CORE DRILLING MACHINE.

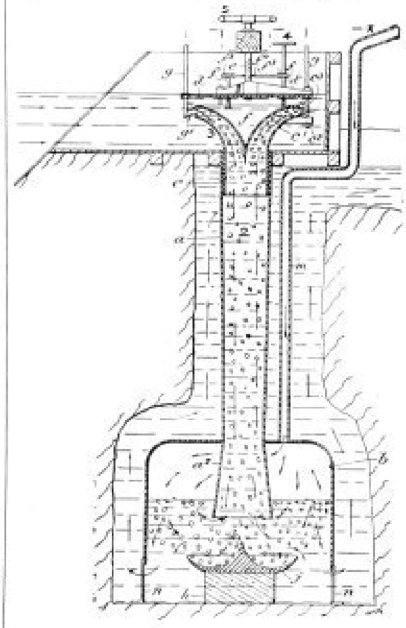
No. 543,227. Moses Beal, Elyria, Ohio. *Patented July 23rd, 1895.* Fig. 1 is a front view of the working parts of the machine; Fig. 2 is a side view of the feed lever; Figs. 5 and 6 are top views of the collars *I* and *J*. This machine is



intended for hand power, and for use in places where larger machines could not be taken. The driving gear and cranks are mounted in a bracket *B*; the windlass *T* is mounted in another bracket *V* at the rear of the post *A*. The drill tube is guided at the top by a collar *N* which turns in a bracket *M*. All these brackets are made to be bolted to a wooden post *A*, which may be cut in the locality where the drilling is to be done. The main tube *E* is made of square pipes which slides through square holes in the hub of the gear *C*, and guide collar *N*. The pipe is swaged round at each end and is threaded to suit ordinary pipe fittings. The drill tube is supplied with water by two pumps which are operated by the rods *O* and cranks *D*, and which are connected by hose to the swivel *P*, at the top of the tube. The feeding is performed by hand, by means of the lever *K*, which hooks under the pins *h*, in the rack *H*, and bears upon the shoulders of the collar *J*. The square tube *E*, having no keyways in it to wear out, is very durable and strong.

HYDRAULIC AIR COMPRESSOR.

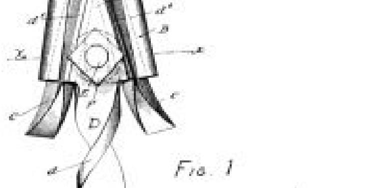
No 543,411. Charles H. Taylor, Montreal, Canada. *Patented July 23rd, 1895.* The degree of compression which can be obtained with this apparatus depends upon the difference in level of the water in the head and tail races. The chamber *b* must also be sunk below the water in the tail race to a distance equal to the working head. The water enters the stand pipes 2 through a conical funnel 3, and descends to the air box *b*, from which it escapes through holes *n*, and passes up the well *m* to the tail race. The funnel is covered by a conical cap *f*, which can be adjusted up or down, by means of the screws and hand wheel 4, to regulate the quantity of water flowing into the funnel. A large number of air tubes *g*, having several small jets each, are arranged in a circle around the rim of the funnel, and these



can be submerged to any extent desired by means of the screw and hand wheel 5. As the water rushes into the funnel, a stream of air bubbles is drawn out from each of the small air jets on the tubes *g*, and these bubbles are carried down by the water into the pipe 2. They are gradually compressed as they descend until they reach the box *b*. Here the water is given a rotary motion by suitable deflecting plates, and the bubbles rise to the surface and separate from the water. The compressed air which accumulates in the box *b* is conducted away, for use, by the pipe *m*. Although the air box is shown as though located in a well, that construction is not necessary. It is only necessary that a sufficient head of water be maintained above it to prevent the air from escaping through the holes *n*.

COAL DRILL.

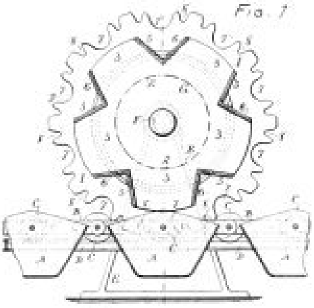
No. 544,206. George H. Bittenbender, Plymouth, Penna. *Patented Aug. 6th, 1895.* Fig. 1 is a side view of the drill head; and Fig. 2 is a cross section at the line *X* of Fig. 1. The end of the auger *A* is formed into a socket *B*, having in-

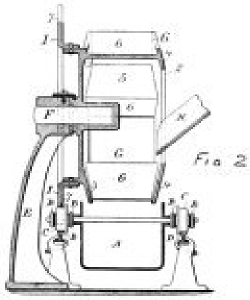


clined side flanges *b*. The central bit *D* has a tapering flat shank with beveled edges. Two side cutters *C*, which are made from triangular steel, are gripped between the center bit *D* and the flanges *b* of the main socket. The single clamping bolt *E* serves to secure all three bits firmly into place. The bits *C* may be shoved forward in their sockets, when desired, to enable them to cut a larger hole; and when they become dulled they can be very quickly replaced with sharp ones.

LOADING CONVEYOR BUCKETS.

No. 541,614. Charles W. Hunt and Charles C. King, West Brighton, N. Y. *Patented June 25th*, 1895. Fig. 1 is a sectional side view, and Fig. 2 is a vertical cross section of the apparatus. The conveyor is composed of an endless series of buckets *A*, which are carried by suitable chains *B*, and rollers *C*. *H* is the loading spout. In ordinary practice, the coal would fall through between the buckets *A*, and be wasted, unless the buckets were made to lap. To prevent all waste, and permit of the separation of the buckets, the wheel

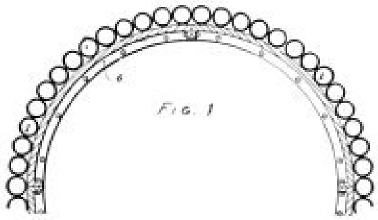


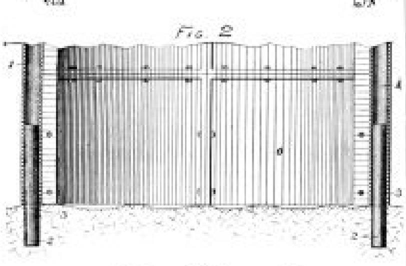


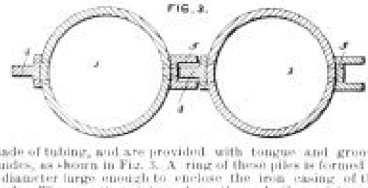
G is employed. This is formed with a number of spouts 3, through which the coal from *H* must pass to reach the buckets. The wheel turns on a pin *F*, upon the standard *E*, being rotated by the engagement of the teeth 7 and 8 with pins upon the chain links, and with the rollers *C*. As the buckets move along, one of the spouts 3, turns squarely down over the center of each bucket, and if any coal should pass out either of the other spouts, it would fall fairly into one of the buckets. Thus all spilling and waste is prevented.

METHOD OF SINKING SHAFT.

No. 543,230. Jesse A. Dubbs, Pittsburgh, Pa. *Patented July 23rd*, 1895. Fig. 1 is a partial top view of a shaft sunk by this process; Fig. 2 is a vertical section near the bottom of the shaft; and Fig. 3 is a cross section, on a larger scale, of the piles employed to enclose the shaft. The piles 1 are



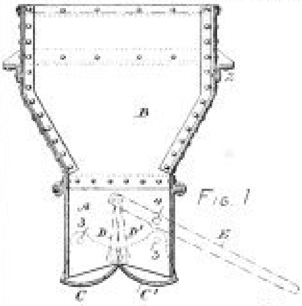


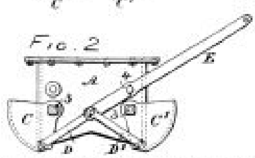


made of tubing, and are provided with tongue and groove guides, as shown in Fig. 3. A ring of these piles is formed of a diameter large enough to enclose the iron casing of the shaft. They are then driven down through the quicksands to the rock. The earth is then cleaned out of the tubes, and a drill is lowered down through them. Holes about four feet deep are drilled beneath each tube, or every alternate one, and an iron pin 3 is driven into each hole. The pins project about four feet up into the tubes and thus prevent them from being pushed out of place when the sand and water are removed from the central part of the shaft. In many cases the piles will form a sufficient lining for the shaft and the sectional casing 6 may be omitted. While not necessary it is generally preferable, to remove the material from the interior of the pile while it is being driven down, so as to permit examination as the direction of movement of of the pile, whether it is being shifted laterally or not, and affording opportunity of correcting any lateral deviation.

GATE FOR COAL CHUTES.

No. 543,182. Charles W. Hunt, West New Brighton, N. Y. *Patented July 23rd*, 1895. Fig. 1 is a vertical section of a coal hopper or chute, showing the gates closed; Fig. 2 shows the position of the gates when open. The gates *C*, *C'* are hung upon pivots 3, which are attached to the sides of the hopper. They are connected by means of links *D*, *D'* to a hand lever *E*, by which they may be operated. The surfaces of the gates are cylindrical, being curved to a circle

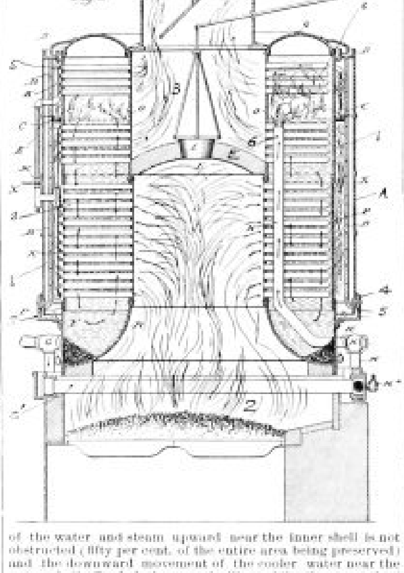




having its center at the pivot 3. The pivots are located nearly midway between the outer edge of the hopper and the middle, so that the effort required to open or close the gates, is about the same. There is no tendency to lift the coal while the gates are closing, consequently they move easily; and when shut, the coal has no tendency to push them open.

STEAM BOILER.

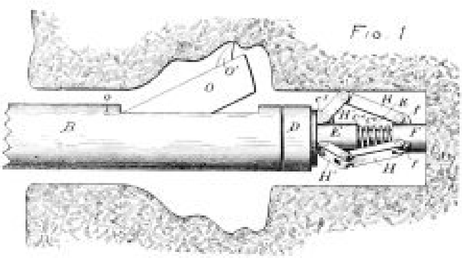
No. 542,674. William H. Berry, Hoosick Falls, N. Y. *Patented July 16th*, 1895. The boiler consists of two vertical cylindrical shells *O* and *P*, one within the other, united at the top by a crowned ring *Q* and at the bottom by a cone-shaped ring or crown-sheet *R*. Since these heads cover a comparatively narrow space they are of thin steel, and do not require bracing, and are threfore sufficiently flexible to accommodate any inequality of expansion in the two shells. Tubes *S S*, of small diameter, radiate from the inner to the outer shell, forming braces for each. These tubes are placed in vertical rows in the inner shell *O*, and are "staggered" in the outer one *P*. By this arrangement the rapid circulation

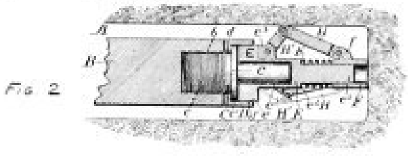


of the water and steam upward near the inner shell is not obstructed (fifty per cent. of the entire area being preserved) and the downward movement of the cooler water near the outer shell afforded the same facility, while the strength of the outer shell is not reduced below the percentage of that of the seams. The fire box is closed by a dome *E*, of fire brick, having a stopper *I* which is opened when cleaning the tubes. The hot gases pass through the tubes to the inside of the smoke jacket *A*, part of them return through the tubes just below the water line, to the smoke box 3; and the remainder pass upward through holes in the check ring *C*, and escape through the tubes which pass through the steam space. The smoke jacket is lined with fire-clay tiles *B*, and it rests on rollers 4, upon the edge of the ring or trough 5, which is filled with sand. A similar sand joint is provided at the top, at *D*. The smoke jacket may be revolved around the boiler, to bring the cleaning doors and flue cleaning pipes into range with any of the tubes. A steam blow pipe *K*, having jets which range with every row of tubes, is attached to the inside of the smoke jacket, and when in use is supplied with steam by a hose. Thus the tubes may be cleaned at any point without stopping the boiler. The furnace 2 is square. The feed water is introduced at *G* where it meets hot water descending from the mud chamber *F* into the flat coil *G'*. The water circulates swiftly through this coil (which is of large pipe) and is delivered close to the water line by the pipe 6. The sediment is swept out of the coil, and is thrown down into the quietest part of the boiler at *F*, from whence it is easily removed.

MINING REAMER.

No. 542,152. Robert H. Elliott and John B. Carrington, Birmingham, Ala. *Patented July 2nd*, 1895. Fig. 1 shows the reamer as at work, enlarging the inner end of a bore hole, to form a powder chamber. Fig. 2 is a sectional

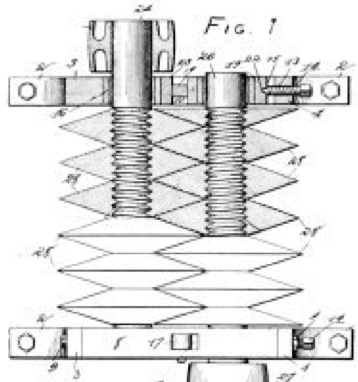


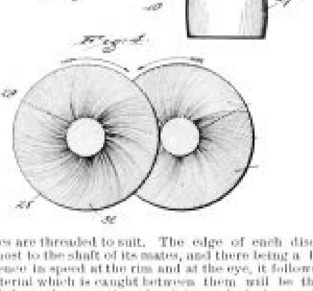


view showing the construction. The object of this improvement is to center the end of the reamer in the hole, and compel the cutter *O* to cut equally on all sides of the bore. The centering device consists of three pairs of toggle links *H H'*, which are jointed to sleeves *F* and *E*. When the reamer is thrust into the hole, the sleeve *F* strikes the bottom, and the links are forced outward against the sides of the hole, thus centering the main spindle. The parts then become stationary, and the plug *C* which is screwed into the end of the spindle, turns within the collar *D*, forming a swivel joint, the thrust being borne upon the enlarged head of the sleeve *E*. As soon as the pressure is removed, the spiral spring *K* will operate to draw in the toggle links, so that the tool may be readily removed from the hole.

GRINDING MILL.

No. 544,294. John D. Evans, St. Louis, Mo. *Patented Aug. 13th*, 1895. Fig. 1 is a top view of the grinding machine partly in section; Fig. 4 is a cross section of the same showing the grinding discs. The discs are thick at the center and taper toward the rim, and the beveled faces are corrugated to suit the material to be ground. They run in the direction of the arrows in Fig. 4. Both shafts are screw threaded, one being right handed, and the other a left handed screw. The





discs are threaded to suit. The edge of each disc reaches almost to the shaft of its mates, and there being a large difference in speed at the rim and at the eye, it follows that the material which is caught between them will be thoroughly rolled at the same time that it is crushed, thus making very effective grinding. It is claimed that the discs will automatically lock themselves in position upon their respective shafts, while the mill is in operation.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 4. SCRANTON, PA., NOVEMBER, 1895. WITH WHICH IS COMBINED THE MINING HERALD.

Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING FOR PLACER GOLD.

A NOVEL AND GIGANTIC SCHEME IN CLEAR CREEK CANYON, COLORADO.

Showing how Gold is Obtained on a Large Scale from Gold Bearing Gravels under Favorable Conditions.

(By Prof. Arthur Lakes, Golden, Colo.)

In our last, we gave an account of the arrangement of pipes, flumes, etc., and of the general plan of the enterprise. In Fig. 1 we give a skeleton sketch showing in detail how the works will appear when all is completed and bedrock reached. Fig. 11 also shows a panoramic view of the works from the intake flume far up the canyon to the penstock and from the penstock the big pipes to their final connection at the lower end of the placer with the giant nozzles, and on the opposite side the river, the big flume carrying the water of the river out of its natural course and leaving its bed dry for operations. We see by Fig. 1, that since our former article a deep wide pit has been dug 30 feet deep just above the stone dam, that giant nozzles are playing against the sides and into the bottom of this pit, washing down the debris of the banks and excavating the bottom, and that gravel elevator pipes and water lifters are forcing up the material as excavated to an elevated sluice to be winnowed of its coarser gold and thence the gravel to pass over a finer gathering broad undercurrent sluice and thence again by a narrow flume winding amongst queer crevices in the rocks (See Fig. 3) to a final long undercurrent where the finest material is collected on "Burlap" a species of rough sacking material well known to the trade.

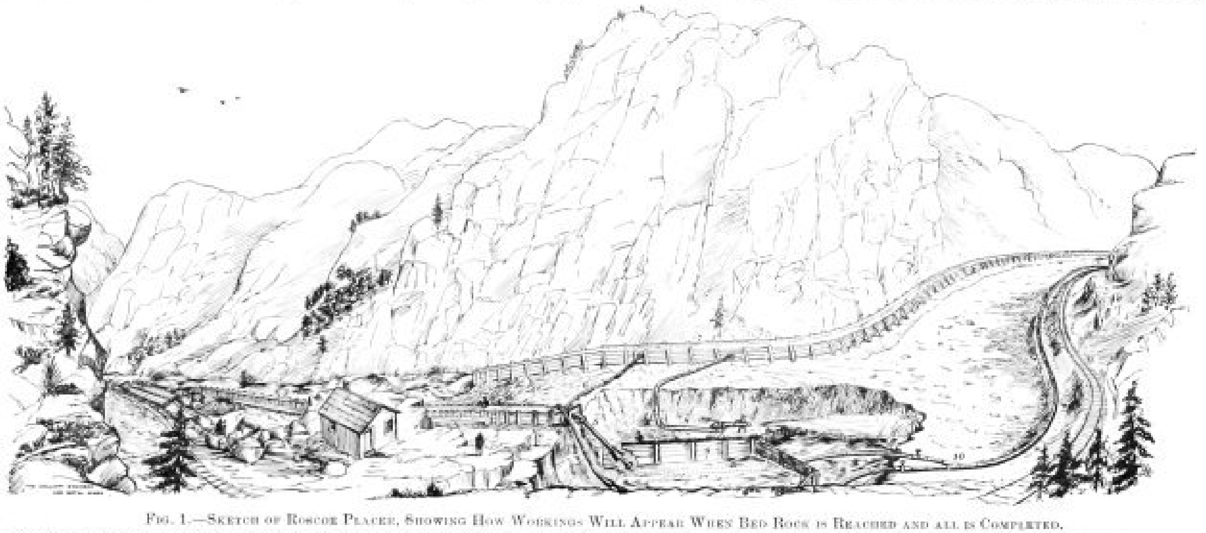


FIG. 1.—SKETCH OF ROSCOE PLACER, SHOWING HOW WORKINGS WILL APPEAR WHEN BED ROCK IS REACHED AND ALL IS COMPLETED.

1, LONG LOWER UNDERCURRENT SLUICE; 2, SMALLER UPPER UNDERCURRENT SLUICE; 3, GRAVEL SLUICES; 4, LUDLUM'S WATER LIFTER; 5, LUDLUM'S GRAVEL ELEVATOR, NOZZLE JUST APPEARS ABOVE BED ROCK, IN WHICH A PORTION OF PIPE IS EMBEDDED, AS SHOWN BY DOTTED LINE; 6, PIPE FROM MAIN FLUME TO CARRY WATER TO GRAVEL SLUICES; 7, THE FLUME; 8, GIANT; 9, WOODEN BOX FOR KEEPING IN MATERIAL FOR ELEVATORS; 10, PIPES.

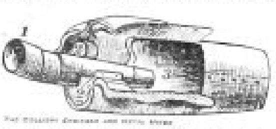


FIG. 2.—INSERTION OF NOZZLE INTO LUDLUM'S WATER LIFTER.

1, GIANT NOZZLE; 2, WOODEN BLOCKS; 3, WATER LIFTER PIPE OPENED, SHOWING NOZZLE.

We will now describe this latter and most important portion of the works in detail. It will be rembered that the general plan of the enterprise is to ransack the contents of the creek bed, down to bedrock and when needed a little below bedrock, all along and up the course of the bed of the creek from which the stream has been removed. After all the machinery, flumes, sluices, pipes and giants were in place, the next thing to be done was to excavate a pit down to bedrock at the stone dam at the extreme lower end of the workings. This is being done by help of giant nozzles and elevators. The plan is to keep working up stream making one long continuous and deep trench the full width of the river bed and the full length of the portion laid bare. The debris of the advancing excavation is thrown back into the portion worked out and abandoned behind.

In commencing the excavation, the giant nozzles were brought to play with their tremendous force and the material as the pit deepened was forced up through the elevator gravel pipe into the elevated gravel sluice (See Figs. 4 and 5). This Ludlum elevator gravel pipe, invented by Mr. Ludlum, is simply a big steel pipe somewhat funnel-shaped and towards the bottom this comes right down into the bottom of the pit where both water and gravel are accumulating under the work of the giants.

Right underneath the open end of the elevator pipe, at a distance of 16 inches below it, is a nozzle imbedded in the bed-rock together with a portion of pipe, as shown by dotted lines in Fig. 1, receiving a powerful pressure of water from one of the main pipes on the bank. As the gravel and stones keep rolling down and by a box are directed in upon this nozzle, the lower portion of which will be sunk in bed-rock when bed-rock is attained, it drives the debris and smaller boulders up the funnel of the elevator and into the flume, where a pipe (See 6, Fig. 1) communicating with the main great flume sends a flood of water into the gravel sluice to help push along the boulders and gravel that have thus come up. The other pipe that is also seen entering the end of the box of the sluice and passing down in a steep slanting direction into the pit, is a Ludlum water lifter sometimes called an elevator pump. It works somewhat like the gravel elevator only a vacuum is caused in the lower portion which causes the water in the pit to ascend into it. The power pressure nozzle is inserted in about a foot into the pipe. (See Fig. 2.) Its purpose is to drain the pit of water, accumulating from the giants and in other ways, so the giants tear down the banks and the elevators carry the water and gravels and gold up into the gravel sluice.

The main gravel sluice (See Figs. 6 and 7) is a narrow

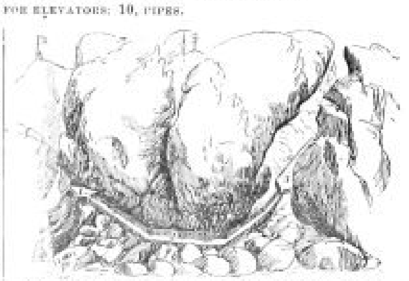


FIG. 3—ADAPTING NATURE TO CIRCUMSTANCES, ROSCOE PLACER.

1 AND 3, UNDERCURRENT SLUICES, 2, FLUME FROM THE -S.

trough or box 208 feet long by 48 inches wide and 3 feet high, laid down at a gentle inclination on the top surface of the creek bed from the lower end of the excavation. It is made of strong, inch thick boards and paved on the bottom with square 8 inch blocks of pine wood set on end so that the grain is uppermost. These block riffles are laid in rows quite close together across the bottom of the sluice from side to side. Between each set or row of blocks is laid a narrow strip of wood 3 inches high by ½ an inch thick. This is laid on the bottom between the riffles as shown in Fig. 7.

In laying in these block riffles the first row of blocks divided into a series of compartments or boxes set longitudinally. The divisions are by long boards about a foot deep, at the bottom of these boards a narrow strip of wood is laid and battened down on the burlap or sacking material which lines the bottom of the box and receives the gold. These burlap carpets are drawn off by rollers on swivels and transported to a wooden tank where they pass over a series of rollers which lays them conveniently open for inspection: every visible particle of gold is collected and the rest drops into the water in the tank.

Through the middle of this undercurrent sluice passes pit to a depth of 30 feet, shows a peculiar section. The great loose rocks, by forming the so-called stone dam across the stream, produced a natural gathering place for all the boulders and rubbish coming down stream from above. Here we may expect at this point the greatest depth that will be encountered before bed rock is reached. Some of the boulders are several feet in diameter and of great size and weight, see Fig. 9. Some of these have to be blasted out, whilst others, later, will be hoisted out by a derrick worked by a dynamo. Mixed with these boulders are a great number of stumps and

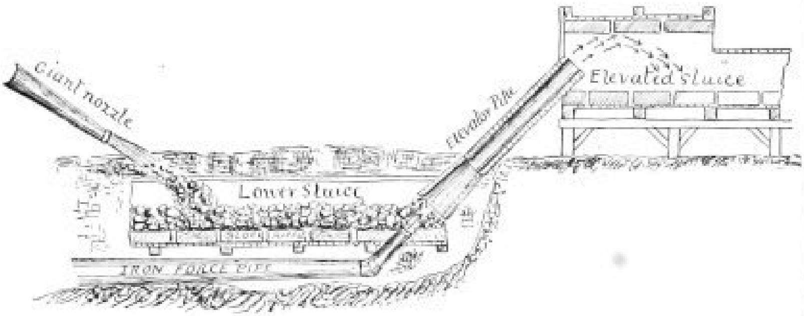


FIG. 4.—LATERAL SECTION LUDLUM'S PATENT GRAVEL LIFTER, ROSCOE PLACER.

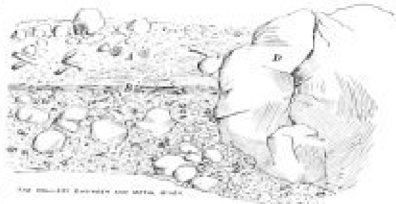
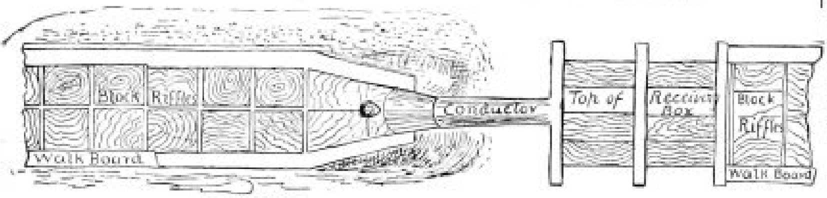


FIG. 9.—SECTION OF PIT AT ROSCOE.

A, BOULDERS, SAND AND DRIFT LOGS, 6 FT., *B*, 2 FEET BLACK PEAT; *C*, BIG ANGULAR BOULDERS AND PEBBLES AND GRAVEL; *D*, BIG BOULDER.



Lower Sluice. *Elevated Sluice.*

FIG. 5.—PLAN LUDLUM'S GRAVEL LIFTER.

are placed closely side by side. Then the strip of wood is nailed along the lower part of them with headless nails not driven home but protruding a little so that when the next row of riffles is laid down they are driven up against the points of the protruding headless nails and made fast whilst a strip in being laid against them.

The gravel, as it is being borne along in the sluice, drops its gold which is collected in these cracks or gaps prepared to receive it between the riffles.

On the side of this main sluice, and connected with it at the head, are two smaller side sluices a little below it and running parallel with it. These are lined with Brussels carpet instead of with riffle blocks. This carpet collects the finer gold whilst the main flume usually collects the coarser material both boulders gravel and gold.

Nearly towards the end of the main sluice a few of the block riffles are omitted and a grating put in their place (See Fig. 7) made the full width of the box with a space between bars of ¾ inch and bevelled on the bottom. This grating only allows stones or gravel of a certain size to pass together with finer material into the next sluice called an "undercurrent." This is a broad

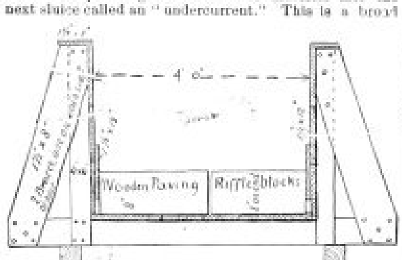


FIG. 6.—CROSS SECTION OF SLUICE.

THE LOWER STRING OF SLUICES ARE THE SAME EXCEPTING THAT THE SIDES ARE BUT 2 FEET HIGH AND 3 FEET APART.

shallow box, as shown in the cut (Fig. 10) dipping at an inclination of 16 inches in 24 feet which is the length of of the undercurrent, its width being 12 feet. In our sketch the box may appear to have a much steeper inclination than this but such is not the case and is a fault in the perspective or foreshortening.

The bottom of this box is lined with a peculiar kind of riffle. These riffles consist of narrow slats or strips of wood laid down on the bottom across the width of the box and on top of each slat is a piece of strap iron nailed flat, whose edge overlaps the slat on both sides on the lower side only ⅜ of an inch. The water passing through these, passes to and fro like an endless pulley and from riffle to riffle, dropping its gold amongst them by the eddies so caused. Still there is a certain amount of finer material carrying still finer gold which escapes this first undercurrent and must not be lost, so from this a narrow flume winding through a curious passage and crevices in the rocks (See Fig. 3) passes out into a still larger and longer undercurrent which catches the finest material, in the present case very largely composed of fine silt and tailings from the stamp mills. The long wide lower undercurrent 48 feet long by 24 feet wide is a small flume with perforated plates at the upper end. This flume is intended to catch and dispose of some of the coarser material that may have passed through the upper undercurrent, and what finer gold there may be in it drops through the perforated plates into the general undercurrent, the coarse rubbish being carried out to the river. When cleaning up day comes, which may occur at uncertain intervals, the block riffles are taken up and carefully inspected for gold. This leaves the bottom of the sluice uncovered, and on this a good deal of gravel and gold and quicksilver has collected. This is carefully shoveled into buckets and examined, the gold laid apart and the quicksilver containing gold placed in retorts. Similarly in the first undercurrent the riffles are taken up and gold and quicksilver collected, also the Brussels carpets in the side sluices and the burlap, as we have described in the lower undercurrent.

The bed of the stream as at present excavated by the

pieces of driftwood, some of which show the marks of the teeth of some ancient beavers. About half way up the side of the section is a thin bed of peaty earth, relics, doubtless, of an old surface soil. Above this are belts of coarse and fine sand, which, by their uneven bedding, show the action of torrents and rapidly changing currents. Gold has been found all the way down from surface to bottom for 30 feet, but they expect the most and coarsest gold when they reach bed rock, which they expect to do daily. They are obliged to wall up with cobble stones portions of the loose sides of the pit, as the jarring of a passing train is liable to shake down boulders and endanger the workmen below.

[TO BE CONTINUED.]

Combine Boilers.

Mr. L. M. Moyes, the patentee and manufacturer of the "Combine Water Tube Boilers" informs us that he has leased the factory premises 1434-36 Randolph St., Philadelphia, Pa., where the manufacturing and assembling of his boiler will be carried on, and where the general offices will be maintained.

He is at present arranging for the incorporating of his business with a view to the developing of the manufacturing department. The "Combine Boiler" is in successful operation, and a series of tests have shown gratifying results.

Mr. Moyes is at present erecting boiler plants at various points, and mentions 200 H. P. for Thos. Kelley, Esq., Phila., Pa.; 100 H. P. for St. Ann's Catholic Schools, Phila.; 125 H. P. for the Marietta Electric Light Co., Marietta Pa.; 130 H. P. Washington Agricultural College, Pullman, Washington.

Mr. Moyes is about to issue the second edition of his catalogue on "Steam Boilers" which will be sent on application, and will contain some interesting reading for steam users.

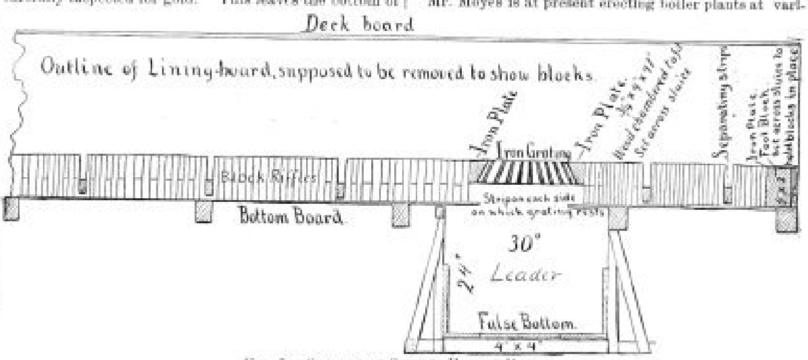
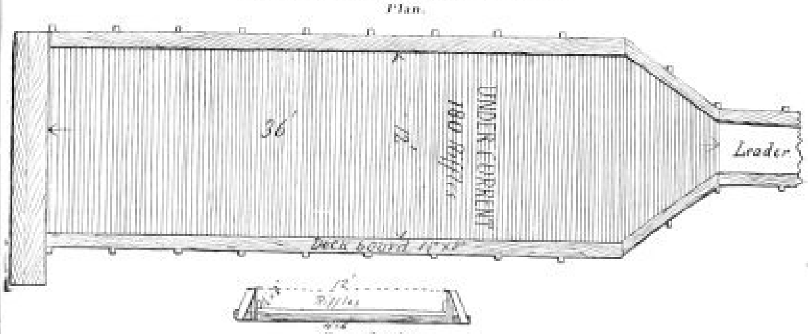


FIG. 7.—SECTION OF SLUICE, ROSCOE PLACER.

Plan.



Cross Section.

FIG. 8.—THE UNDERCURRENT SLUICE.

ELECTRICITY IN BITUMINOUS COAL MINING.

THE EVOLUTION AND DEVELOPMENT OF MINING MACHINES.

Practical Tests Made in Various Ohio Mines with the Principal Electrical Mining Machines, with a tabulated Statement of the Results.

By R. M. Haseltine, Mining Engineer, Chief Inspector of Mines of Ohio.

(From advance sheets of his Annual Report.)

The subject of mining coal by the aid of machinery has received renewed consideration each year, as its importance has become more apparent to the industry. This is especially true since the recent industrial depression has fallen upon the commercial world. Coal has been mined in Ohio in this way to a greater or less extent during the past seventeen or eighteen years, but not until within the past two years has it become plainly manifest that, upon the present basis governing the relations of pick to machine mining, the latter has such a decided advantage. It is believed that within this period the subject has received more attention than during any other period since its inception. While this is true, the subject of mining coal by the aid of machinery is by no means of recent birth. The records in the U. S. Patent Office show that as early as 1858 it had materialized to such a point as to be considered patentable. The first claim filed in this country and the first patent ganted on a mining machine was No. 19,545. It was issued to C. A. Chamberlain, of Allegheny City, Pa., on March 9, 1858. This pioneer inventor conceived the idea of attacking the coal by means of a horizontal wheel in the perimeter of which he inserted cutters. On October 23, 1858, seven months later, Mr. E. Simpkins of the same place filed a claim upon which patent No. 21,918 was issued. The inventive genius of this man led him to conceive the idea of imitating the miner with his pick. This claim stands to-day as the only application ever having been filed for protection on a pick machine.

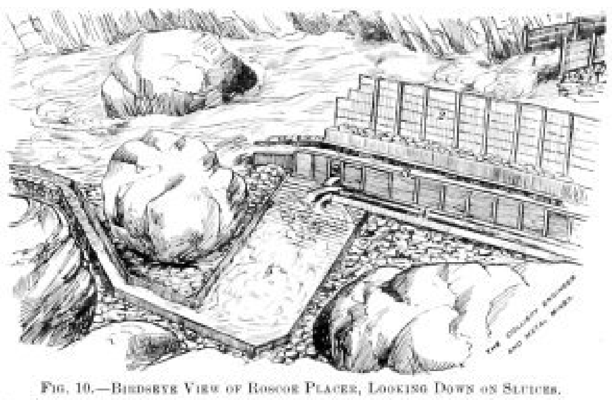


FIG. 10.—BIRDSEYE VIEW OF ROSCOE PLACER, LOOKING DOWN ON SLUICES.

1, THE GREAT FLUME; 2, A FENCE TO KEEP OFF FRESHETS; 3, SLUICE FOR COARSE MATERIALS; 4, SLUICES FOR FINER GOLD; 5, UNDERCURRENT SLUICE.

Grier and Boyd, of Hatton, Pa., secured a patent July 12, 1864, on a machine which consisted of a series of augers working in unison in the same plane. Their patent number was 43,493. This would be classed as an end cutting machine, and was the first "auger machine" upon which a claim was presented at the Patent Office. A number of machines of this type have recently been designed to be driven by electricity. It has been found that the bit being in constant contact with the coal becomes heated, which removes the temper. It has also been discovered that as the augers advance while displacing the coal they become less rigid and have a tendency to become tangled. The circular saw has suggested one of the popular ideas among inventors as to the suitable device by which to reclaim the coal from nature's store house. This plan was first made public in this connection by J. S. Frisk and James Westerman, of Meadville, Pa., who filed a claim on a device which consisted of two parallel saws so arranged that the hub was between them. It was claimed that by this means a cut could be made as deep as desired. They were granted a patent covering their claim on January 17, 1865. It was numbered 45,917. The first claim on a reciprocating machine was made by G. E. Donesthorpe, of Leeds, England, on which patent No. 76,417 was issued, on April 2, 1868. Whitcomb's first patent on a reciprocating machine was issued January 18, 1876, and Harrison's first patent on the same pattern of machine was issued on September 2, 1879. J. Alexander, of Girtsherrie, Scotland, entered the first claim on a "chain machine" which was designed as a side cutter and on which patent No. 135,874 was issued to him on February 18, 1873. A patent for a double chain machine constructed so that they moved in opposite directions was issued to C. S. Lechner, of Ohio, on October 23, 1883, and in 1886 a patent for a single chain end cutting machine was issued to V. & C. S. Lechner. On October 6, 1874, a patent for a rotary bar machine to which was attached an air blast for removing the slack was issued to P. Sheldon. This is the first record of a machine of this type. The patent number is 155,593. During January and August, 1879, patents on the details in cutters were issued to F. M. Lechner, of Columbus, Ohio, to whom, during January and September, 1880, patents were issued on an end cutting rotary bar machine. B. A. Legg also secured a patent on a rotary bar machine on January 3, 1884. This by no means embraces the list of claims that have been filed or of the patents that have been allowed upon mining machines in this country. It however gives those which were first to exhibit principles of merit as well as those which contained principles of mechanics that are now being used in the construction of machines that are regarded as having passed the experimental point. These patents also exhibit the range of thought over which inventors have gone in their endeavor to produce coal by the aid of mechanics, and with what eagerness they have tried to solve a problem that even to-day retains many mysteries. To those who are familiar with the progress made in this branch of industry, the small percentage of the claims which have been found to possess merit will appear quite startling. It is possible that the machines of many of the early inventors fell short of success for want of suitable power with which to operate them, the science of electricity being in a primitive condition and the air compressors being very imperfectly understood. For this and reasons hereinafter considered, it is doubtful if the number of economic mining machines on the market at the present time will exceed a half dozen.

There are many reasons why the energy of so many inventors has not been crowned with greater success. One is that mining machines are operated in caverns of Egyptian darkness into which even inventors who have this problem under consideration rarely enter, hence the machine escapes the gaze of the inquisitive mechanic who is constantly prying into ingenious devices which are exposed to the light of day. This results in the skilled mechanic and the inventor having little or no knowledge as to the requirements of a successful mining machine or to the amount of labor that it must perform. They are equally ignorant as to the rough usage that it must withstand in order to reclaim a ton of coal with economy to the mine operator. Although the most intelligent and skilled miners, thoroughly versed in their vocation, are usually selected to operate the mining machines, as miners they are entirely wanting in the knowledge of mechanics and are therefore unable to calculate as to the amount of additional strength required or of the form or place to apply it in order that the machine may withstand the resistance offered by the coal. It will be readily seen that the mining machine is thus deprived of suggestions, alterations and improvements that would be offered by both mechanics and inventors, were it operated where it would be exposed to the public eye as are other labor saving devices. Even since the introduction of the first economic machine, which was about 1876 or 1877, there have been scores of machines patented and placed on the market, many of them possessing features that would have been of great value to the mining industry had they been fully developed, but upon trial they were found to be too frail, and after a number of vexatious delays, caused by breakage, the were consigned to the scrap pile and the disheartened inventor found himself forced to abandon his hope of reward, and return to his former vocation. Had he been possessed of a knowledge as to the units of work that are required to undercut the coal, he would have increased the factor of safety in his calculations and the result might have been more satisfactory.

But few coal veins are adapted to machine mining at all and in a still smaller number can the present type of standard machine be used with economy. For profitable mining the roof must be strong and free from slips or bell shaped balls. Especially is this true of the rotary bar or of the end cutting chain machine, either of which cannot be well operated if the props are set less than twelve feet from the coal face. The floor of the coal vein must be nearly if not quite level to admit of the successful working of machines. There is no instance within the writer's knowledge where the mining machines have given satisfaction when operated on an uneven floor. The thickness of the vein has been considered as the index by which its adaptability for the introduction of mining machines is to be determined, and with but few exceptions, no attempt at any installation has been made except in the very thickest of the veins, and so machine builders have designed only for the mining of high coal. For this reason the practicability of using machines in reclaiming the coal in thin veins still remains undecided. This is largely owing to the fact that the fiber of the coal is as firm in the thin veins as in the thick, so that the power required to undermine the coal remains the same, hence the weight of the machine must be as great for one as for the other. The diminished space in which to use the bars by which the machine is moved, also the necessity of using a shorter bar, thus diminishing the leverage, makes the moving of the machine very laborious and slow and thus diminishes the opportunity of profit that might be derived from their installation. With a view of widening the field of machine mining, some manufacturers have turned their attention to the designing of a machine that would be of such a height as to not come in contact with the roof while being moved, but the weight of the machine was so great that it offered no encouragement to the operators in thin veins. The mere fact that a machine is of a height that will permit of its being readily moved is no guarantee that it can be profitably used in that vein. It is an old rule in mining to make the undercutting the same depth as the coal vein is thick. If a proper amount of powder is then judiciously used, the coal will be liberated in its best possible form.

The present type of bar or chain machine is designed to undercut from six to seven feet and where the vein is from eight to twelve feet in thickness, this is of course much less than than the rule would require. In such an instance great difficulty has been experienced in producing merchantable coal, owing to its flaking off in thin slabs so shattered as to not stand handling.

It has been found that a seven-foot machine must be much heavier than one that is designed to undercut but six feet, hence it is the writer's belief that if in these veins the machines were designed to undercut from three and one-half to four and one-half feet, as the thickness of the vein would demand, it could be so reduced in weight as to be readily moved into position. Such a machine would be designed to undercut the full thickness of the vein and the coal thus produced will enter the markets in as good form as if it were the product of pick mining.

In making installations, operators have generally adopted one of the three types of machine. These are the rotary bar, the chain and the reciprocating patterns, and in these investigations only the two former have been considered, for the reason that they received the greater consideration among the operators, presumably from the fact that they have been regarded as the most profitable to operate. The manufacturers of the reciprocating machine lay claim to holding a priority in

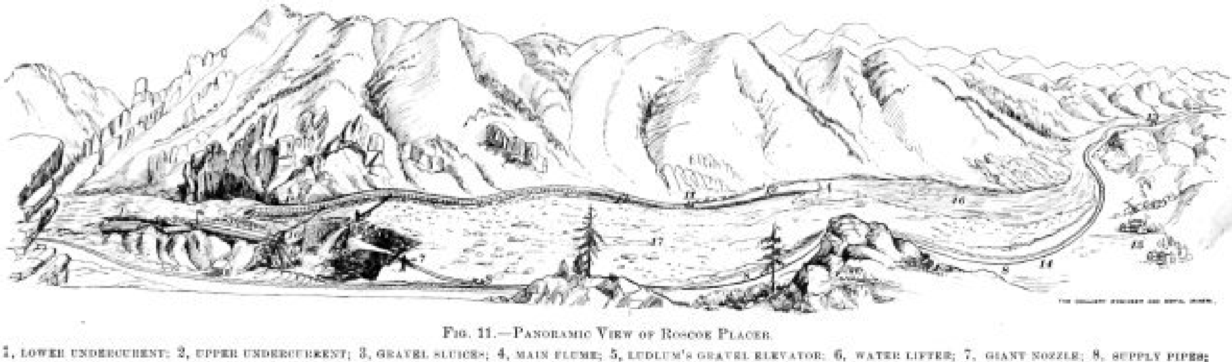


FIG. 11.—PANORAMIC VIEW OF ROSCOE PLACER.

1, LOWER UNDERCURRENT; 2, UPPER UNDERCURRENT; 3, GRAVEL SLUICES; 4, MAIN FLUME; 5, LUDLUM'S GRAVEL ELEVATOR; 6, WATER LIFTER; 7, GIANT NOZZLE; 8, SUPPLY PIPES; 9, THE PIT; 10, STONE DAM; 11, GRIZZLY BARS; 12, NATURAL FLUME WITH EMBANKMENT; 13, PENSTOCK; 14, JUNCTION OF ALLEN'S STAVE PIPE WITH STEEL PIPE; 15, COMPANY'S HOUSES; 16, RIVER; 17, DRY RIVER BED.

entering the field. The age in this case cannot be definitely settled without first knowing which was the first to pass the experimental point. This type of machine, however, holds a very important part in the industry and is indispensable in a mine where machines of the other types are installed. In such cases it is used to do the cutting near faults where the coal contains balls of iron pyrites, etc., or other foreign matter. It is a machine that can be employed advantageously in driving narrow entries or in mining under tender roof. This type of machine is also regarded with much favor by the operators in the thin veins, owing to the ease with which it can be transported about the mine. It is designed to undercut a depth of four and one-half feet, which in many of the thin veins is ample to insure the production of a merchantable coal.

The early installations of mining machines, beginning about 1877, were confined to the use of compressed air as a motive power. This continued until early in the year of 1889, when electricity was first successfully applied to a rotary bar machine by the Jeffrey Manufacturing Co., of Columbus, Ohio. This machine is still in use in the mine in which it was first installed. The ease and economy with which this new power could be conducted about the mine commanded for it at once the attention of the inventor and operator. It placed the employment of the mining machine within the reach of a greater number of operators, and the development of machine mining has gone forward rapidly since that date.

The question of operating mines by electricity has received more discussion during the past six years than any subject before the mining public. And the few years elapsing since the first introduction of electricity has witnessed its successful application to every labor saving device in the industry in which compressed air had formerly been utilized. Furthermore, it has been known that the amount of power required to operate the mining machines has been reduced; also that the construction of the mining machine has been improved and that new and improved machinery has been designed to attack the coal in a more advantageous manner. Still there has been no careful investigation of this progress or no published information for which the public has been the wiser. It would seem that the efficiency of the power, its adaptability to the uses of the mine, the amount of it required to do a given amount of work, the loss in transmission, etc., were questions which should have received ere this the most careful investigation and the results placed before the mining public. The absence of this information can only be accounted for on the assumption that the persons who desire it dislike to undergo the necessary hardships and inconveniences, much less to perform the labor, whereby it can be acquired.

By reason of the scarcity and incompleteness of this information, which is absolutely necessary in order to intelligently discuss the subject, the writer has devoted several weeks to the making of practical tests as to the relative efficiency of the labor saving machines in the mines of Ohio. In order to set forth the results of this labor in a compact and lucid form, they are here presented in the accompanying table. It will be seen that visits were made to seven mines located in various parts of three of the most important coal fields of the State. Tests were made of twelve mining machines of the several types that are now regarded as standard machines. In securing these results the circuit was opened near the machine and meters registering potential and current were inserted. Simultaneous readings were taken every fifteen seconds while seventy-three cuts were being made. It will thus be seen that the results as they appear in the table embody the averages of over 1,400 readings, all of which were taken and reduced with the utmost possible precision.

In arranging this table it was thought desirable to show the comparative efficiency of the various types of mining machines while at work under the circumstances which the ordinary daily routine presents. It was also the purpose of the designer to exhibit the results of the tests made and the deductions drawn therefrom, as well as such other circumstances as would bear upon their value.

In the first column have been placed the names of the mines, and in the next the names of the operators, the county in which the mine is located and the character and capacity of the power plant. In the next column is represented the name of the machine, which also indicates its maker, and in the next the type of the machine. The fifth column exhibits the number of cuts that the machine made while being tested. It will be noticed that the number of cuts varies with the different machines. This was caused by a series of uncontrollable exigencies, which are liable to arise at any moment during the progress of such an investigation. For instance, on several occasions it was found that the machine had but few cuts to make before a change to another part of the mine, perhaps for want of a place in which to cut; and several times the testing was interrupted by the stopping of the generator and by breakages of the machine. On one or two other occasions the work was stopped to allow the experimenting party to catch a train. Thus it will be seen that it was almost impossible to secure an equal number of trials to each machine. In the next two columns appear the average depth and breadth of each cut. The former was obtained by measuring the depth of the undercut in several places and striking an average. These figures should not be considered as representing the depth which the machine is capable of cutting, as often the contour of the coal face is such that the machine is prevented from getting into a position that will permit it to make its full cut. The average width of the cut, as made during the trial, which appears in the next column, does not represent the capabilities of the machine with regard to the width of the cut. The reason why the machines are seldom set to make their full cut arises from the fact that a bar machine, so set, by reason of the impossibility of making the two adjoining cuts parallel invariably leaves a "stump" in the undercut, while in the case of the chain machine, when the cuts are made the full width, there is left a projecting angle, at the back where the two cuts adjoin. In either case the shooting down of the coal is seriously interfered with. For these and other reasons it has been found economical with the present type of chain or bar machine to cut less than the width of the machine. The next column represents the number of square feet undermined at each cut, and the next the time occupied by the machine in making the cut. By this is meant the period elapsing from the time the machine first caught the coal until the desired distance under was attained and the machine reversed. In the next column is registered the average gross horse-power consumed in making the various cuts. The instruments were read every fifteen seconds during the time occupied in cutting and the first two sub-columns give the maximum and minimum readings, respectively, while the third gives the average horse-power for the cut. In the next column is given the fractional load, which was obtained by running the machine light, with and without the feed. The next column exhibits the average net horse-power used in cutting, which embraces the average horse-power minus the frictional load. In the next column is represented the average horse-power required by the machine to undercut one square foot of coal in one minute of time. This is designed to reduce the efficiency of each machine to a common standard for comparison. In the last columns appears the average voltage for each cut, which has been introduced to show whether or not the machine worked under any disadvantage from this source.

By referring to the average of each machine tested as they exhibit the different factors considered, it will be seen that the average maximum horse-power of the five bar machines is eighteen and one-half, nineteen and four-tenths, twenty-two and nine-tenths, twenty-six and nine-tenths and twenty-six and eight-tenths, while the chain machine shows twenty-one and six-tenths, fourteen and seven-tenths, nineteen and six-tenths, nine and eight-tenths, seventeen and two-tenths, twenty-two and twenty and one-half horse-power, respectively. These results are of the highest value to persons who contemplate the installing of mining machines. They should use the highest power exhibited under the type of machine selected as the multiple by which to determine the power of the generator necessary to insure satisfactory results. Neglect in following this rule is a very common error practiced among the manufacturers of machines. They appear timid in presenting proper estimates of cost lest they discourage the operator and thereby lose the installing of a plant. Hence they take the chances of the maximum power not being required, or of being able to reinforce the power plant after the operator has discovered that a mistake has been made. Thus it is that at many plants the limit of power demanded is so close to the capacity of the plant. The minimum horse-power in the next column is of no particular value, beyond giving the amount of power required to undercut the coal under the most favorable circumstances. In the next column will be found the average horse-power required to make each cut, also the average horse-power required at each machine during the time that it was tested. It conveys the amount of power that must be ready at all times in order to operate the plant with any success. From this column there can be obtained a general knowledge of the resistance offered by the coal in different portions of the State as well as a general knowledge as to the relative efficiency of the several types of machines that are in use in the industry. It will be observed that in the column of averages for machines, the horse-power consumed by the rotary bar machine appears as sixteen and one-half, seventeen, eighteen and nine-tenths, and twenty-two and seven-tenths, while the chain machines show eight and six-tenths, twelve and five-tenths, fourteen and five-tenths, fifteen and three-tenths, sixteen, sixteen and three-tenths and eighteen and one-tenth. If the number of cuts are taken into consideration, it is found that the general average horse-power required by the bar machine is eighteen and seven-tenths, while for the chain machine the average is fourteen and four-tenths horse power. This shows by a comparison of all the coal cut during this inquiry, that the chain machine required four and three-tenths horse-power less than the rotary bar machine. The required power to overcome this frictional load of a machine is of vital importance, as it is so much power wasted to the operator. Under this heading in the subdivision of "Feed on" will be found the amount of power required to set each machine in motion, entirely apart from that used in cutting coal. This column shows that one chain machine required three and sixteen one-hundreths horse-power; one, three and fifty-one one-hundredths horse-power; one, three and seventy-seven one-hundredths horse-power; two, four and twenty-seven one-hundredths horse-power; one, four and thirty-four one-hundredths horse-power and one, six and three-tenths horse-power. The first mentioned was a new machine of the most approved workmanship, and was doing its second day's work. With the rotary bar machine the horse-power was five and thirty-one one-hundredths, one other was six and three-fourths horse-power, while three were between seven and one-tenth and seven and seven-tenths horse-power. It is obvious that each horse-power saved in the frictional load is a clear profit to the operator. If from the average horse-power required to make each cut, is deducted the horse-power required to overcome the frictional load, the result is the net horse-power consumed in cutting the coal. This average will be found to vary as does that of each cut. We again find the lowest powers indicated to be that of the chain machine which were five and four-tenths horse-power and eight and two-tenths horse-power. Then two show ten and two-tenths and ten and three-tenths respectively, then one eleven and eight-tenths, one twelve and two-tenths and one thirteen and eight-tenths. The lowest average for the rotary bar machine appears at nine and three-tenths and the highest at sixteen horse-power.

The average, as seen in the foregoing columns of the table, will convey to the reader a very concise idea of the elements which are important to consider in machine mining. It will be observed that each average considered is in a measure dependent upon the others, also that they vary with each machine whether compared in distant mines or in the same one. The relative efficiency of the several machines being under consideration, it was therefore desirable to compare them by a common standard, which is attempted in the column headed "H. P. Required to Undercut One Sq. Ft. of Coal in One Minute." It will be observed that the results include the frictional load. This was necessary, as the resistance offered varies with each machine, hence the power here indicated represents both that required to displace the coal and that required to overcome the friction of machinery. If the trials here considered had all been made in the same piece of coal, the results would give an absolute comparative efficiency for the machines here considered, but for obvious reasons this was impracticable, hence the comparative efficiency will differ in so far as the amount of resistance offered by the coal in one mine is greater or less than that encountered in another. It will also differ with the amount of variation in the coal fiber of the different parts of the same mine. From this column it will be seen that the lowest power as shown by a chain machine was four and two-tenths horse power. This machine was at the Snake Hollow mine, where the coal is said to be the best for pick mining of any in the Hocking Valley. The machine had the full power of a 150 horse power generator, which gave it a uniform potential. The next machine in order required five and seven-tenths horse power. This is followed by four requiring from six and one-tenth to six and nine-tenths, and one which was consuming eight and five-tenths horse power.

The rotary bar machine requiring the lowest power was located at Murray City, in Hocking county; which was eight and nine-tenths horse power. This is followed in order by one requiring nine and two-tenths horse power; one, nine and five-tenths horse power; one, ten and eight-tenths horse power; and one twelve and two-tenths horse power, which is the highest in the list. Had these results been obtained in the same piece of coal they would at once establish the pre-eminent superiority of the chain machine. By a further comparison it will be seen that at Murray City, where both types were together in the same coal, there is a difference of two and six-tenths horse power in favor of the chain machine. At New Pittsburg and at Rock Run both types under the same conditions exhibit the advantage in favor of the chain machine, of three and one-half horse power in the first instance and two and three-tenths horse power in the second. At the Congo mine in Perry county, there appears the best opportunity to form a fair comparison as to the relative efficiency of the several makes of types of machine under consideration. In making these tests each machine had the full potential of the plant, and each was started with sharp knives. Care was taken that each machine be given an equal opportunity. The coal in this mine is harder than that of any machine mine in the State, and the machines that have so far been installed here have been built with increased strength to withstand the severe stress. The amount of resistance offered by the coal here will be more fully appreciated when it is known that the operators manufacture their own knives, which are said to exceed in number those made by the Jeffrey Manufacturing Company, and the cost of which has been estimated to amount to two and one-half cents per ton of lump coal produced. It will be observed that the two chain machines, which differ in the former comparison of averages, require six and seven-tenths horse power each, while the rotary bar machine required twelve and two-tenths horse power or forty-five per cent. more power than either of the chain machines to undercut one square foot of coal in one minute. By deducting from these averages the frictional load of each machine, the result obtained will be the amount of power required to displace the coal alone at the rate of one square foot in one minute. This calculation shows that at the Walhonding mine it would require three and thirteen one-hundredths horse power; at New Pittsburg the chain machine would require one and forty-three one-hundredths horse power and the bar machine two and four one-hundredths; at Orbiston the bar machine requires two and fourteen one-hundredths horse power; at Murray City the chain required two and fifty-nine one-hundredths horse power; and the bar three and thirty-nine one-hundredths horse power; at Snake Hollow the chain required but one and four-one-hundredths horse power, the lowest ever known; at Congo the two chain machines consumed two and thirty-six one-hundredths and two and forty-three one-hundredths horse power, respectively, while the rotary bar machine in the same coal and with like advantages, required four and fifty-one one-hundredths horse power, the highest in the list; at Rock Run the chain machine used two and twenty one-hundredths horse-power, and the rotary bar four and four one-hundredths horse power. In the mines were both types of machine are employed a comparison will show that at New Pittsburg the chain machine saves sixty-one one hundredths horse-power; at Murray City, eighty one-hundredths horse power; at Congo, two and eight one-hundredths and two and fifteen one-hundredths, or forty-eight per cent. and forty-six per cent., respectively; at Rock Run one and eighty-four one-hundredths horse power, or but fifty-four per cent. of the power required by the bar machine. These results seem to vindicate the theory of the writer expressed in a former article, in which it was asserted that the chain was the most approved instrument by which to cut coal. This belief was based upon the laws which govern the woodsman who cuts with the grain of the wood. The coal which is composed of decayed vegetation has retained its stratification, the difference between the two propositions being that in the tree the grain is vertical, while in the coal it lies horizontally. That is, that the chain machine, like the miner with his pick, attacks the coal with the grain and not across it. That is, it splits out a portion of the fiber and leaves the cleavage both above and below smooth and undisturbed. The misapplication

TABLE OF EXPERIMENTS.

MADE WITH ELECTRICAL MACHINES IN SEVEN OF THE MINES OF OHIO, COMPLETED JULY, 1895. THE RESULTS ARE THE AVERAGE PRODUCT OF 1,400 READINGS TAKEN WHILE 12 OF THE VARIOUS TYPES OF STANDARD MACHINES WERE OCCUPIED IN MAKING 75 CUTS. MADE BY R. M. HASELTINE, CHIEF INSPECTOR OF MINES.

Name of Mine.	Name of firm operating mine.	Name of machine.	Type of machine.	No. cuts made.	Depth of cut. Feet.	Depth of cut. Inches.	Width of cut. Feet.	Width of cut. Inches.	No. of square feet undercut.	Time in making cut. Minutes.	Time in making cut. Seconds.	Electrical H. P. used in cutting. Max.	Electrical H. P. Min.	Electrical H. P. Average.	H. P. required to overcome frictional load. Feed off.	Feed on.	To Feed.	Net horse power used in cutting metal.	H. P. required to undercut 1 square foot in 1 minute.	Voltage at machine.	General Remarks.
Walhonding	Cam. Con. Coal Co.,	Morgan-Gardner.	Chain.	1	4	6.0	3	2.0	14.2	3	30	18.3	10.3	14.5	......	3.77	......	10.7	6.3	224	Coal short-grain and cuts easily.
"	Guern.	" "	"	2	4	6.0	3	2.0	14.2	3	27	23.0	12.4	15.0	......	3.77	......	11.2	6.5	215	
"	Ball engine, 150 H. P.,	" "	"	3	4	6.0	3	2.0	14.2	3	10	21.6	12.9	16.1	......	3.77	......	12.3	6.5	207	
"	two Morgan-Gardner	" "	"	4	4	6.0	3	2.0	14.2	3	50	25.2	12.0	16.5	......	3.77	......	12.7	7.2	216	
"	Generators, 80 H. P.	" "	"	5	4	6.0	3	2.0	14.2	5	......	23.6	9.3	13.6	......	3.77	......	9.8	7.2	224	
"	each; main conduc-	" "	"	6	4	6.0	3	2.0	14.2	3	50	25.6	11.8	17.8	......	3.77	......	14.0	7.5	224	
"	tor (0000). Conductor	" "	"	7	4	6.0	3	2.0	14.2	3	15	17.7	12.3	15.6	......	3.77	......	11.8	6.5	223	
"	into rooms No. 1.	" "	"	8	4	6.0	3	2.0	14.2	3	45	23.6	11.8	19.2	......	3.77	......	15.1	7.8	228	
					4	6.0	3	2.0	14.2	3	45	21.6	11.6	16.0	......	3.77	......	12.2	6.9	219	Averages for machine.
N. Pittsburg	Johnson Bros., Hock,	Jeffrey	Bar.	1	6	4.8	3	4.8	21.8	4	45	18.6	16.3	17.3	5.83	7.16	1.33	10.1	9.3	227	Rock roof.
"	One U. S. and one	"	"	2	6	4.8	3	4.8	21.8	5	53	16.0	13.2	14.7	5.83	7.16	1.33	7.5	9.2	215	Coal very curly and hard.
"	Mathias Generator, 80	"	"	3	6	4.8	3	4.8	21.8	5	10	17.3	12.6	15.7	5.83	7.16	1.33	8.5	9.1	215	
"	H. P. each. Engine 160	"	"	4	6	4.8	3	4.8	21.8	4	50	19.4	13.9	15.9	5.83	7.16	1.33	8.7	9.1	218	Cutter bar 5 feet, 6 inches long.
"	H. P.	"	"	5	6	4.8	3	4.8	21.8	5	5	19.0	13.2	17.0	5.83	7.16	1.33	9.8	9.4	224	
"	This company is	"	"	6	6	4.8	3	4.8	21.8	4	45	19.2	11.5	17.8	5.83	7.16	1.33	10.6	9.4	231	
"	more extensively	"	"	7	6	4.8	3	4.8	21.8	4	37	19.3	15.1	17.5	5.83	7.16	1.33	10.3	9.3	231	
"	known as the N. Pitts-	"	"	8	6	4.8	3	4.8	21.8	4	45	19.3	16.1	17.0	5.83	7.16	1.33	9.8	9.2	228	
"	burg Coal Co.	"	"	9	6	4.8	3	4.8	21.8	4	45	18.6	14.8	15.9	5.83	7.16	1.33	8.7	9.0	218	
"					6	4.8	3	4.8	21.8	4	57	18.5	14.0	16.5	5.83	7.16	1.33	9.3	9.2	224	Averages for machine.
"		Jeffrey	Chain.	1	6	9.6	3	......	20.4	4	......	14.6	9.8	12.6	4.24	4.27	.03	8.3	5.8	241	Rock roof. Coal hard and curly. Chain designed to cut 3 feet, 3 inches in width.
"		"	"	2	6	9.6	3	......	20.4	3	45	14.8	6.6	12.2	4.24	4.27	.03	7.9	5.7	241	
"		"	"	3	6	9.6	3	......	20.4	3	35	15.4	10.4	12.3	4.24	4.27	.03	8.0	5.6	242	
"		"	"	4	6	9.6	3	......	20.4	3	50	14.2	12.2	12.8	4.24	4.27	.03	8.5	5.8	240	
					6	9.6	3	......	20.4	3	47	14.7	9.7	12.5	4.24	4.27	.03	8.2	5.7	242	Averages for machine.
Orbiston	Raybould Bros., Ath.	Jeffrey	Bar.	1	5	7.0	3	1.0	17.1	3	15	16.2	10.9	14.6	6.80	7.36	.56	7.2	8.7	224	Coal soft.
"	Engine 150 H. P.; T.	"	"	2	5	7.0	3	1.0	17.1	3	45	18.0	10.7	16.0	6.80	7.36	.56	8.6	9.2	224	
"	H Generator 150 H. P.	"	"	3	5	7.0	3	1.0	17.1	4	25	19.3	10.8	15.5	6.80	7.36	.56	8.2	9.4	222	Cutter bar 3 feet, 3 inches long.
"		"	"	4	5	7.0	3	1.0	17.1	3	50	16.8	11.7	14.5	6.80	7.36	.56	7.2	8.9	231	
"		"	"	5	5	7.0	3	1.0	17.1	4	10	18.3	10.0	16.4	6.80	7.36	.56	9.1	9.5	219	
"		"	"	6	5	7.0	3	1.0	17.1	4	......	22.4	14.2	20.1	6.80	7.36	.56	12.8	10.3	225	
"		"	"	7	5	7.0	3	1.0	17.1	4	5	21.4	13.9	18.8	6.80	7.36	.56	11.5	10.0	226	
"		"	"	8	5	7.0	3	1.0	17.1	4	5	24.0	16.2	20.7	6.80	7.36	.56	13.4	10.4	225	
"		"	"	9	5	7.0	3	1.0	17.1	3	55	20.6	12.5	18.3	6.80	7.36	.56	11.2	9.8	225	
"		"	"	10	5	7.0	3	1.0	17.1	3	25	17.4	7.8	15.6	6.80	7.36	.56	8.5	9.1	232	
					5	7.0	3	1.0	17.1	3	54	19.4	11.9	17.0	6.80	7.36	.56	9.7	9.5	226	Averages for machine.
Murray City	Greendale Furn. Co.,	Jeffrey, Jr.	Bar.	1	6	......	3	......	18.0	4	25	22.7	18.3	19.6	3.54	5.31	1.77	14.3	9.2	189	Knives had made 7 runs before testing began. Coal of average hardness.
"	Hocking.	"	"	2	6	......	3	......	18.0	4	50	19.4	16.1	17.2	3.54	5.31	1.77	11.9	8.5	196	
"	Sperry Gen'r, 125 H. P.	"	"	3	6	......	3	......	18.0	3	35	26.5	10.4	20.1	3.54	5.31	1.77	14.8	8.3	193	
"	Buckeye eng., 150 H. P.				6	......	3	......	18.0	4	26	22.9	14.9	18.9	3.54	5.31	1.77	13.6	8.7	192	Averages for machine.
"		Independent	Chain.	1	6	9.6	3	3.6	22.4	5	15	22.5	14.8	20.0	3.34	3.51	.17	16.5	7.3	175	First two cuts were made with dull knives. On third cut sharp knives were set in. Coal of average hardness.
"		"	"	2	6	9.6	3	3.6	22.4	5	15	30.3	13.4	19.4	3.34	3.51	.17	15.9	7.2	175	
"		"	"	3	6	9.6	3	3.6	22.4	5	45	20.7	10.7	13.8	3.34	3.51	.17	10.3	6.1	182	
"		"	"	4	6	9.6	3	3.6	22.4	5	5	15.0	10.9	12.3	3.34	3.51	.17	8.8	5.4	187	
"		"	"	5	6	9.6	3	3.6	22.4	5	......	17.8	12.9	14.3	3.34	3.51	.17	10.8	5.9	193	Chain designed to cut 3 feet, 6 inches in width.
"		"	"	6	6	9.6	3	3.6	22.4	4	50	16.5	11.5	14.2	3.34	3.51	.17	10.7	5.7	194	
"		"	"	7	6	9.6	3	3.6	22.4	5	10	17.6	10.8	14.1	3.34	3.51	.17	10.6	5.9	191	
"		"	"	8	6	9.6	3	3.6	22.4	4	45	16.8	13.9	14.1	3.34	3.51	.17	10.6	5.7	198	
					6	9.6	3	3.6	22.4	5	8	19.6	12.1	15.3	3.34	3.51	.17	11.8	6.1	187	Averages for machine.
Snake Hol'w (new)	C. L. Poston, Hocking	Jeffrey	Chain.	1	5	7.2	2	8.4	15.1	3	......	9.9	7.7	9.0	3.02	3.16	.14	5.8	4.3	223	Machine has full power of generator, which is 2,000 ft. distant from the machine. Coal is very pure and cuts easily. Chain designed to cut 3 feet, 3 inches in width.
"	General Electric Gen-	"	"	2	5	7.2	2	8.4	15.1	3	10	9.9	7.7	8.6	3.02	3.16	.14	5.4	4.3	224	
"	erator, 150 H. P.; Mc-	"	"	3	5	7.2	2	8.4	15.1	2	45	9.2	7.3	7.6	3.02	3.16	.14	4.4	3.9	221	
"	Ewen engine, 150 H. P.;	"	"	4	5	7.2	2	8.4	15.1	2	40	10.1	7.8	9.3	3.02	3.16	.14	6.1	4.2	220	
"	main conductor (0000);	"	"	5	5	7.2	2	8.4	15.1	3	5	10.4	7.1	9.2	3.02	3.16	.14	6.0	4.4	216	
"	new type of power	"	"	6	5	7.2	2	8.4	15.1	3	7	9.5	8.2	8.8	3.02	3.16	.14	5.6	4.3	215	
	board automatic cir-	"	"	7	5	7.2	2	8.4	15.1	2	50	9.6	6.8	7.9	3.02	3.16	.14	4.7	4.0	213	
	cuit breaker.				5	7.2	2	8.4	15.1	2	57	9.8	7.5	8.6	3.02	3.16	.14	5.4	4.2	219	Averages for machine.
Congo	Turney & Jones, Perry	Jeffrey	Chain.	1	5	9.6	2	7.2	15.0	3	30	15.4	10.8	12.8	4.24	4.27	.03	8.5	6.2	243	Coal very hard. Sharp knives on first cut. Ten sets of knives required to the shift. Chain designed to cut 3 feet, 6 inches in width.
"	Two U. S. Generators,	"	"	2	5	9.6	2	7.2	15.0	3	40	15.6	10.6	13.5	4.24	4.27	.03	9.2	6.5	244	
"	80 H. P. each; Ide en-	"	"	3	5	9.6	2	7.2	15.0	3	12	19.0	12.5	15.4	4.24	4.27	.03	11.1	7.0	244	
"	gine, 160 H. P.	"	"	4	5	9.6	2	7.2	15.0	3	38	19.8	15.2	16.9	4.24	4.27	.03	12.6	7.3	243	
"		"	"	5	5	9.6	2	7.2	15.0	3	35	16.1	12.2	13.8	4.24	4.27	.03	9.5	6.5	247	
"					5	9.6	2	7.2	15.0	3	37	17.2	12.3	14.5	4.24	4.27	.03	10.2	6.7	244	Averages for machine.
"		Independent	Chain.	1	6	2.0	3	3.6	20.4	3	30	24.0	14.2	18.9	4.17	4.34	.17	14.6	6.8	246	Coal very hard. Machine has been largely rebuilt at the mine by the Congo Co. Sharp knives on 1st cut. Top knives again changed on 4th cut.
"		"	"	2	6	2.0	3	3.6	20.4	3	35	28.7	19.4	21.6	4.17	4.34	.17	20.3	7.8	242	
"		"	"	3	6	2.0	3	3.6	20.4	3	25	18.1	12.2	15.0	4.17	4.34	.17	10.7	6.1	246	
"		"	"	4	6	2.0	3	3.6	20.4	3	30	17.1	10.7	14.3	4.17	4.34	.17	10.0	6.0	245	
"		"	"	5	6	2.0	3	3.6	20.4	3	27	22.3	13.9	17.9	4.17	4.34	.17	13.6	6.6	246	
"					6	2.0	3	3.6	20.4	3	29	22.0	14.1	18.1	4.17	4.34	.17	13.8	6.7	245	Averages for machine.
"		Jeffrey	Bar.	1	5	6.0	2	8.4	14.8	4	45	27.2	14.2	20.3	7.09	7.69	.60	12.6	11.7	230	Coal very hard. Sharp knives on first and fourth cuts, 12 sets of knives required to the shift. Length of cutter bar, 3 feet.
"		"	"	2	5	6.0	2	8.4	14.8	4	45	25.7	13.6	22.4	7.09	7.69	.60	14.7	12.4	228	
"		"	"	3	5	6.0	2	8.4	14.8	4	25	28.7	22.2	25.3	7.09	7.69	.60	17.6	12.8	225	
"		"	"	4	5	6.0	2	8.4	14.8	4	15	25.2	17.9	22.0	7.09	7.69	.60	14.3	11.8	226	
"		"	"	5	5	6.0	2	8.4	14.8	4	25	27.8	18.6	23.3	7.09	7.69	.60	15.6	12.3	224	
					5	6.0	2	8.4	14.8	4	32	26.9	17.3	22.7	7.09	7.69	.60	14.9	12.2	247	Averages for machine.
Rock Run	C. & H. C. & I. Co.,	Jeffrey	Chain.	1	6	4.8	2	9.2	17.7	3	35	21.1	13.6	16.2	5.70	6.30	.60	9.9	8.3	239	Coal of fine quality and easily cut. Machine said to have made 60 cuts in seven hours. Chain designed to cut 3 feet, 3 inches in width.
"	Perry.	"	"	2	6	4.8	2	9.2	17.7	3	55	20.5	14.2	16.6	5.70	6.30	.60	10.3	8.6	236	
"	U. S. Generator, 80 H.	"	"	3	6	4.8	2	9.2	17.7	3	45	20.3	11.8	16.9	5.70	6.30	.60	10.6	8.5	238	
"	P. Engine 100 H. P.,	"	"	4	6	4.8	2	9.2	17.7	3	50	20.7	10.6	16.6	5.70	6.30	.60	10.3	8.5	241	
"	main conductor, (0000).	"	"	5	6	6.0	2	4.8	13.7	3	45	20.0	10.2	16.6	5.70	6.30	.60	10.3	8.8	240	
"					6	4.8	2	8.3	17.3	3	46	20.5	12.1	16.6	5.70	6.30	.60	10.3	8.5	239	Averages for machine.
"		Jeffrey	Bar.	1	5	10.0	3	1.8	18.2	4	15	23.7	13.6	19.3	6.52	6.76	.24	12.6	9.4	235	Coal easily cut.
"		"	"	2	5	10.0	3	1.8	18.2	4	30	24.4	16.8	23.6	6.52	6.76	.24	14.9	10.4	232	
"		"	"	3	5	10.0	3	1.8	18.2	4	30	29.2	21.4	25.0	6.52	6.76	.24	18.3	11.3	228	
"		"	"	4	5	10.0	3	1.8	18.2	4	35	29.8	17.8	25.0	6.52	6.76	.24	18.3	11.3	217	
					5	10.0	3	1.8	18.2	4	27	26.8	17.4	22.7	6.52	6.76	.24	16.0	10.8	228	Averages for machine.
N. Pittsburg	Johnson Bros., or N.	Jeffrey Elec. Drill.	......	1	6	9.6	......	......	......	2	30	3.6	2.8	2.8	......	.90	......	1.9	......	245	Cuts a two-inch hole.
"	Pittsburg Coal Co.	"	......	2	7	......	......	......	......	2	18	2.9	2.2	2.2	......	.90	......	1.3	......	239	
"		"	......	3	6	7.2	......	......	......	2	35	2.5	2.2	2.6	......	.90	......	1.7	......	237	
"		"	......	4	7	......	......	......	......	2	18	3.3	2.2	2.6	......	.90	......	1.7	......	241	
					6.5	8.4	......	......	......	2	30	3.2	1.6	2.5	......	.90	......	1.6	......	249	Averages for machine.

A Morgan-Gardner projectile machine at the Walhonding mine was tested during a three-minute cut and found to require 3.75 horse power at a voltage of 225 v.

At the Orbiston mine a small motor driving an emery wheel was tested and found when running light to require 1.94 horse power, and when grinding bits, 1.33 horse power. At the same mine an electric pump of the triplex pattern was tested. This pump was made by Gould & Co., of Seneca Falls, N. Y., for exhibition at the World's Fair. Has a ten horse power motor and four-inch suction and five-inch discharge, forcing water 2,000 feet, and a height of seventy-eight feet. When running light it consumed an average of 3.4 horse power and when pumping, 4.6 horse power.

At the Murray City mine a motor driving a seven-foot Ray & McConnel fan, which was producing 43,000 feet of air per minute, was tested and found to require an average of 10.4 horse power.

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of power as exhibited in the rotary bar machine may appear clearer, if the reader will imagine a revolving shaft set with knives so arranged as to cut parallel to its axis, and attacking the end of a piece of timber. To be compared to this would be a saw running horizontally and being applied to the side of timber.

The economic results that accrue from machine mining form the vital factor of the subject under consideration. In the pursuit of information on this subject it was found difficult to obtain a wide range of record as to the amount of coal that machines of the reciprocating pattern are capable of producing. Great difficulty was experienced, also, in securing data by means of which to compare the results obtained by this type of machine, with those of the rotary bar or chain machine. This, in the main, was owing to the fact that the veins in which the reciprocating machines are most exclusively installed, differ greatly from those in which the other types of machine can be profitably used. For instance, in the mine where the former type is used exclusively the veins are much thinner than those in which the latter machines are employed. Again, in the latter class of mines a portion of the product is often secured by pick mining, of which the amount of small coal is not kept separate, therefore the results here considered lack the breadth of observation that the writer had desired. Futhermore, where all types are employed in the same mine, the projectile machine is mostly used to work around faults and in places where the coal is defective, hence its capacity is not considered important and no record is kept of the work performed even when it is cutting under favorable circumstances. However, the following interesting figures were obtained with reference to a reciprocating machine using air as a motive power, and by comparing it with electrical machines of the same pattern, and of apparently equal efficiency, we may arrive at a fairly accurate conclusion with regard to the general merit of the machine when using electricity as a motive power. The facts that were obtainable show that in a four and one-half-foot vein which is free from impurities, the reciprocating machines average twenty-eight tons of lump coal daily, which equals forty-two and one-half tons run of mine. In this vein this represents an average undercutting of about 170 square feet. The cost of mining is based on a ton of 2,000 pounds of lump coal. This is considered equivalent in this mine to 3,030 pounds run of mine loaded in the mine car at the room face. The practice is to subdivide this, giving to the machine man and his helper, conjointly, one-fifth, and to the loaders one-half of the price paid to the pick miner for the same amount of coal. Thus, on a basis of sixty cents for pick mining, the undercutting would cost twelve cents and the loading thirty cents per ton. At this mine the power is estimated to cost five cents per ton additionally, which, if added to the above, will make the total cost of a ton of lump coal in the mine car at the working face, forty-seven cents. The true amount of coal here represented, is lump, 2,000 pounds, nut, 424 pounds, slack and pea, 606 pounds, a total of 3,030 pounds. In another vein, which has an average thickness of three and one-half feet, the average space undercut daily during 1894 is given as 168 square feet, and the average daily production of each machine is twenty-one and three-fourths tons of lump coal. This is after it has passed over a one and one-quarter-inch screen of sixty feet area. The coal in this vein is strong in fiber and has well defined joints, hence it mines in large blocks. This will be more clearly seen by a glance at the production which consists of seventy and eight-tenths per cent. of lump, seven and seven-tenths per cent. of nut, and twenty-one and one-half per cent. of slack; or in a ton of coal, 2,000 pounds would be lump, 217 pounds nut, and 607 pounds slack, which is equivalent to 2,825 pounds run of mine.

At this mine during the two years previous when the coal was produced exclusively by pick mining, the proportion of lump was seventy-two and four-tenths per cent., of nut, eight and eight-tenths per cent., and of slack, eighteen and eight-tenths per cent. Thus it will be seen that the output of the mine, when produced by machines, contains two per cent. less lump, one per cent. less nut, and three per cent. more slack than when displaced by the pick of the miner. It is regretted that the horse-power required to operate compressed air machines of this type could not be obtained for this article, but it will be seen by referring to the foot notes of the table, that a Morgan-Gardner electric machine of this type, and of apparently equal efficiency, was tested in the Walhonding mine in Guernsey county. It was found that to operate it to its capacity required three and three-fourths horse-power.

In the consideration of the rotary bar and chain machines it will be observed that the wage scale, while based upon the price paid in pick mining, suffers a much greater subdivision. For instance, when pick mining is sixty cents, eleven cents per ton is paid for cutting entries, room necks and all narrow work, while for undercutting in rooms and for all wide work the price is eight cents per ton. For loading coal in the entries and room necks and for all narrow work, thirty-six cents is paid; for loading out of breakthroughs between rooms, thirty-seven and one-seventh cents, and in rooms and for all wide work the price is thirty cents per ton. Drilling preparatory to blasting the coal down, when done by the machine man, pays two cents per ton, while, if the loader does it, he receives three cents per ton. On this schedule it is found that the cutting and drilling costs ten and four-tenths cents per ton, and the loading, thirty and seven-tenths per ton. Thus it will be seen the cost of the coal on the mine car is forty-one and three-tenths cents per ton, exclusive of the power. It has been found that the cost of power per ton of coal produced has not been determined at any electrical mine within the range of this inquiry. Therefore, to compare results, the cost of power in the first case must be deducted. It will then be found that a ton of coal produced by the projectile machine is worth, exclusive of power, forty-two cents, while by either of the others the cost is forty-one and three-tenths cents. It will thus be seen that with either type of machine the cost of the coal, exclusive of the cost of power, is substantially the same.

As the cost of mining is based on a ton of 2,000 pounds of lump coal it is evident that the amount of fine coal produced is an important factor to the operator; and the relative amount produced by any type of machine enters largely into the question of its adoption. With the projectile machine the undercut is about four and one-half feet in depth, and in order to get the necessary height in which to make the full cut, it is customary to block down the coal along the edge to a height of eighteen inches, gradually decreasing to a height of about four inches at the back of the cut. When coal is mined in this way it contains a large amount of nut, pea and slack. Investigations on this point show that in a vein four and one-half feet in thickness, the lump coal equals sixty-six per cent., the nut forteen per cent. and the pea and slack twenty per cent. of the output. The records show that by pick mining in the same vein the lump formed sixty-five per cent., the nut fifteen per cent. and the slack and pea twenty per cent. of the entire output. These proportions were the result of passing the coal over a screen of sixty square feet area with spaces of one and one-half inches beween the bars, while the nut passed over three-quarter inch spaces. In another instance where the coal is three and one-half feet in thickness, the average proportion for the last two years has been lump, seventy and eight-tenths per cent., nut, seven and seven-tenths per cent., and slack, twenty-one and one-half per cent. During the two years preceding, when the coal was all produced by pick mining, the proportion of lump was seventy-two and four-tenths per cent., nut, eight and eight-tenths per cent., and slack, eighteen and eight-tenths per cent. The coal at this mine passed over a screen of sixty square feet area with one and one-fourth inches between the bars, while the nut passed over a three-fourths inch screen. A comparison of the above results shows that the results do not differ greatly in the production of small coal. It therefore follows that in a mine, situated conveniently to a market, the reciprocating machine is a desirable type to install. Again, where the coal is mined under a lease in which the royalty is based upon the lump coal, this type of machine will compare favorably with the pick miner whom it imitates. The rotary bar machine is found to carve a space about five inches in width, the chippings from which, on account of their fineness, are known as "Buck dust." All of this is thrown away and is therefore a total loss. As a rule this comes from the best portion of the vein. In the case of the chain machine it has been found that the space excavated is practically the same as that of the rotary bar machine. It is claimed that twenty-five per cent. of the cuttings are of a size that can be sold as pea coal, but in order to secure this it is necessary to take out the entire mass and screen it. It is therefore questionable if, after the dust has been hauled away and dumped, there is any profit in removing it from the mine. To get a comparison of the amount of fine coal produced by this type of machine with that produced by pick mining, has been found quite difficult; as, to select different mines would be unfair and where both methods are employed in the same mine, the fine coals are not weighed separately. Therefore the range of comparison is of necessity much narrower than was expected when this inquiry began. The comparison here made is based on the production of a mine located on the divide between the Sunday Creek and Hocking Valleys, where pick mining has recently been supplanted by machines, and the product of which is about equally divided between the rotary bar and the chain machines. By referring to the first comparison it will be seen that when the coal was produced by pick mining, the lump coal represented sixty-six per cent., the nut fourteen per cent., the pea six per cent. and the slack fourteen per cent. of the output. Since the introduction of mining machines the lump coal represents seventy-two per cent., the nut twelve and one-half per cent., the pea one and one-half per cent. and the slack fourteen per cent. of the production. It will thus be seen that in this instance the machine increases the amount of lump six per cent. and that it decreases the nut one and one-half per cent. and the pea four and one-half per cent., while the percentage of slack remains the same; so that when the coal was produced by pick mining, a ton of lump represented 3,030 pounds, but since the installation of machinery a ton of lump represents but 2,777 pounds run of mine. It will be readily observed that the projectile machine in the first instance in producing 2,000 pounds of lump coal produced 424 pounds of nut and 606 pounds of slack, while the pick miner in the same mine in producing 2,000 pounds of lump coal added 462 pounds of nut and 615 pounds of slack, a total of 3,077 pounds. At the mine where the second comparison was made the reciprocating machine in reclaiming 2,000 pounds of coal added 218 pounds of nut and 607 pounds of slack, a total of 2,825 pounds. Here the pick miner in mining 2,000 pounds of lump coal also mines 243 pounds of nut and 519 pounds of slack, a total of 2,762 pounds. Where the comparison was made with the rotary bar and chain machine it is found that while they produce 2,000 pounds of lump, there is an added tonnage of 347 pounds of nut, forty-two pounds of pea and 389 pounds of slack, a total of 2,778 pounds. In this mine the pick miner with every 2,000 pounds of lump coal, delivers additionally 424 pounds of nut, 182 pounds of pea and 424 pounds of slack, a total of 3,030 pounds. It will be deduced from the above comparisons that owing to the variation in the amount of fine coal produced by the several methods treated, to make the comparison on the relative cost of lump coal would be misleading. Therefore, to make the matter clearer the comparative cost of a ton of run of mine coal on the sixty-cent scale will be taken as the basis of the following calculation. In the case of the projectile machine first considered a ton of run of mine coal, exclusive of power, costs twenty-seven and seven-tenths cents, while a ton produced by pick mining costs thirty-nine cents. In the second comparisons made with the same type of machine covering a period of two years, the cost of a ton of run of mine coal is found to be twenty-nine and seven-tenths cents, while coal produced by pick mining during a like period cost forty three and one-half cents per ton run of mine. By comparing the rotary bar and chain machine, it is found that a ton of run of mine coal, exclusive of the power, costs twenty-nine and seven-tenths cents, while in the same mine when produced by pick mining it costs thirty-nine and six-tenths cents. This comparison indicates an apparent advantage in the use of the projectile machine, which will be largely equalized when the number of tons that each type of machine produces daily is taken into consideration.

A pertinent phase of the mining machine question, and one that has attracted the notice of the writer in his official capacity, is that of casualty in machine mining. Whenever coal has been mined by machinery and the records are available, a marked decrease is shown in the accident list. As an illustration, in Hocking county during 1894, seventy-three per cent. of the coal was mined by machinery, which amounted to 1,453,391 tons and but one fatal accident occurred in producing this enormous amount of coal. In the counties of Athens, Jackson and Perry each of which produced substantially an equal amount of coal, there occurred fifteen fatalities. A very small percentage of this coal was produced by mining machines. The State of Ohio during 1894 produced an output of 11,910,219 tons. In mining this there occurred forty-five fatal, 116 serious and ninety-six accidents of a minor character, or a total of 257 accidents, yet of all this number not one could be attributed directly to the mining machine. One of the principal reasons to be assigned for this is the fact that the number of men exposed to danger in machine mines is reduced nearly one-half. Again, the men selected to operate the machines and prepare the coal for their successful operation are usually of the highest order of intelligence to be found among the craft. Then there may be an element of selfishness which prompts the operator to use additional precaution in order to protect his $1,500 machine, and thereby furnish greater security to the mine employes.

Written for THE COLLIERY ENGINEER AND METAL MINER.

AN AUTOMATIC SWITCH.

For Rapid and Economical Handling of Coal at Shaft and Slope Heads.

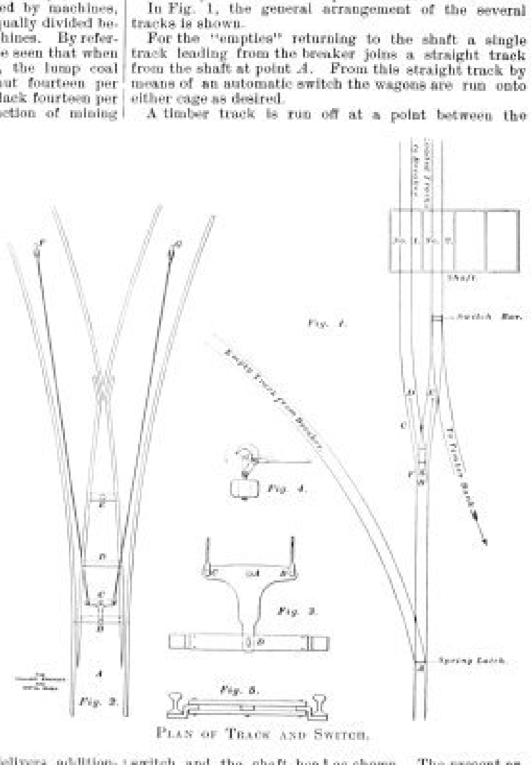
(By Baird Halberstadt, E. M.)

At the Packer No. 5 Colliery near Girardville, Pa., the shaft has four compartments for hoisting, two of which only are in use at the present time.

In Fig. 1, the general arrangement of the several tracks is shown.

For the "empties" returning to the shaft a single track leading from the breaker joins a straight track from the shaft at point *A*. From this straight track by means of an automatic switch the wagons are run onto either cage as desired.

A timber track is run off at a point between the switch and the shaft hea l as shown. The present arrangement of the timber track is but temporary and



PLAN OF TRACK AND SWITCH.

will, when the contemplated improvements are completed, connect with the straight track at a point between *A* and *B*. It will be observed that by the present arrangement, timber is lowered only through compartment No. 2.

As has been said the hoisting is done in two compartments. An empty car or wagon returning from the breaker runs by gravity to point *A*, Fig. 1. At this point a spring latch is placed. The grade of the shaft track is toward the shaft. A car passing point *A* continues on its course on an ascending grade until its momentum is overcome, when it is spragged and held until a loaded wagon has been brought up on the cage. The car is then released and runs onto the cage pushing the loaded car ahead of it and starting it toward the breaker.

For example, suppose the cage in compartment No. 1 has arrived at the head of the shaft with a loaded wagon, the switch is then set for the car to run on the track leading to this compartment.

At points *D* and *E* (Fig. 1) are placed hooks (Fig. 4); the passage of the car axle over one of these drives it forward to the second position as shown by dotted lines in Fig 4. Attached to these hooks and passing backwardly to the lever bar to which they are attached at points *B* and *C* (Fig. 3) are two round iron bars (½ inch) which impart the motion given the hooks, to the lever bar which in turn imparts it to the switch rails drawing them right and left to the main track as desired. If the hook at point *D* is in the position shown by the dotted line, that at *E* is in position shown by the full line, (Fig. 4).

As the cages in the shaft are lowered alternately the passage of a car over the hook on one track sets the switch to run the next car over the other.

In Fig. 2 the switch proper is shown on an enlarged scale. At point *E* is a pivot about which the switch moves. Between the points *A* and *B*, the switch rails are tapered as shown. At point *C* the lever bar works on a pivot. At *D* the switch rails are secured by a ½ inch iron plate 3 inches wide. At point *B* are the double bars and rail seats. An enlarged drawing of this is shown in Fig. 5.

Under the frog an iron plate (½ inch) is laid which permits of the free motion of the switch rails at this point. In Fig. 2 the switch is shown not fixed for either track. In Fig. 3 is shown, on an enlarged scale, the lever bar and the double plate bars, a section of these last is shown in Fig. 5. The apparatus has been in use for a number of years at the colliery and it has given and continues to give excellent satisfaction.

The switch was planned by Col. D. P. Brown, Division Superintendent of the Lehigh Valley Coal Company, and it was made by the colliery blacksmith under Col. Brown's direction.

A NEW CONVEYOR.

Important Improvements in Conveying Machinery for Coal, Ore, or Other Heavy Materials.

Through the courtesy of the Link-Belt Engineering Co. of Nicetown, Phila., we are able to illustrate and describe in this issue an important improvement in conveying machinery.

Monobar is the name given by the inventor to a new chain for long distance conveying and elevating, which combines strength, lightness, simplicity and durable qualities, and is destined to take a leading place among new and useful appliances for work of this class. Monobar may be briefly described as a series of bolts, flexibly connected, with attachments for conveyor flights or elevator buckets. Fig. 1 shows its appearance as employed in a conveyor, and will suggest to those familiar with chain conveying a superior advantage in that no material can lodge on the chain, or be carried under the wheels. Its construction is shown in Fig. 2, in which the malleable iron joint is in light tint and the abutting ends of the bolts in full shading. Having no welds, which are the chief points of weakness in wrought chains, and the malleable joints being so proportioned as to be in all cases stronger than the wrought iron

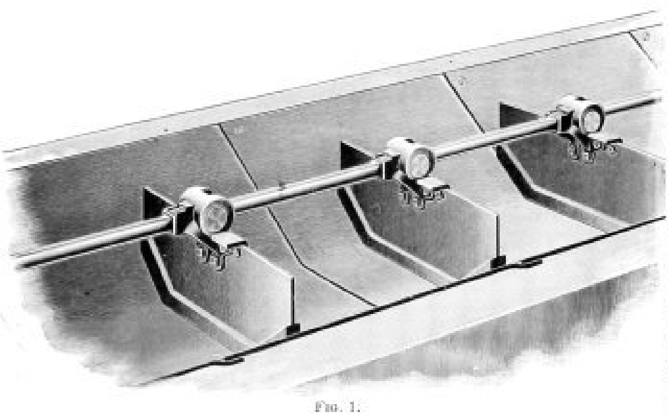


FIG. 1.

bolts, the strength of the chain is that of a high-grade wrought iron bolt of the diameter employed. This, for a one-inch bolt is about 29,000 lbs. No distortion occurring up to the actual breaking point of the bolts, Monobar is stronger for its weight than any other chain in use. Its design permitting and indicating the use of long bolts, the joints are relatively few, and both weight and wear are consequently reduced. It is detachable at every joint and readily and quickly assembled or taken apart. Accurate adjustment to pitch is secured by turning the nut on the end of each bolt, and, as the nuts are locked while in working position, this adjustment is permanent. The wearing surfaces are larger than in any known chain, and are designed for free lubrication while in motion. There is absolutely no wear on the bolts, so that restoration of the chain to its original con-

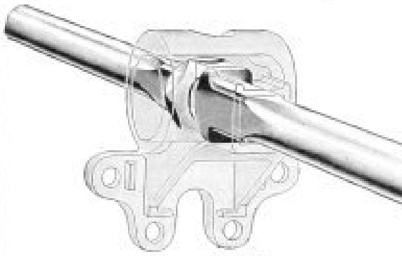


FIG. 2.

dition requires only a renewal of the joints, when, after long service, they have become worn out.

The first cost of manufacture being materially less than that of any standard chain for long distance conveying, the invention presents the double advantage of low first cost and cheap maintenance. The claims made for Monobar are substantiated by the record it has made in actual service. Conveyors in which it is employed as a chain, varying in length from 260 ft. to 600 ft. from end to end, have been in operation for some time past. One of them, 450 feet long, has been operated for the past six months by the Kidder Coal Co. at Wilkes-Barre, Pa., in conveying culm from the bank to the washery. The conveyor has been in steady use ten hours per day, exposed to the weather, and has been run without lubrication or attention. Under date of October 17, the superintendent of the Kidder Coal Co. writes:

"We have used four other styles of chain, and find the Monobar conveyor superior to any of them. It is easy to disconnect, and costs practically nothing for repairs. The equalizing gears largely overcome the lashing or uneven motion caused by the long pitch."

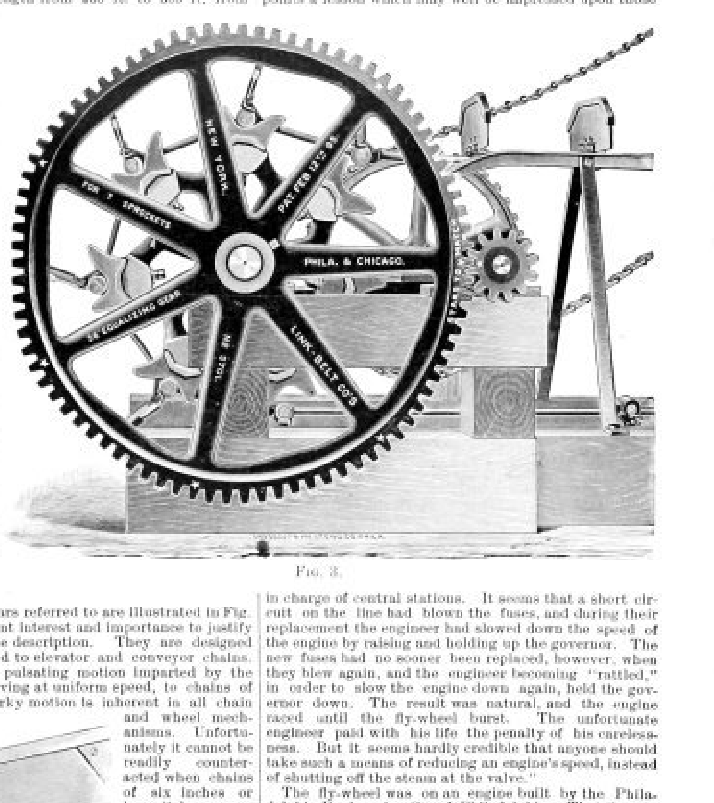


FIG. 3.

The equalizing gears referred to are illustrated in Fig. 3, and are of sufficient interest and importance to justify a somewhat complete description. They are designed to give uniform speed to elevator and conveyor chains. They counteract the pulsating motion imparted by the driving wheels revolving at uniform speed, to chains of long pitch. This jerky motion is inherent in all chain and wheel mechanisms. Unfortunately it cannot be readily counteracted when chains of six inches or less pitch are employed, though equally destructive, if less noticeable, than in case of longer links.

In the illustration a seven-tooth sprocket wheel is shown driving a chain of 18" links. As each link engages the driving sprocket, it is controlled by a radius 20¾" long, measured from the center of the sprocket wheel to the center of the hinge joint of the chain. When the wheel has made one-fourteenth of a revolution (or one-half the movement necessary to bring the next link of the chain into engagement with its sprocket) the controlling radius is reduced to 18⅝" (measured from center of wheel to middle of chain link.) This action is like that of a connecting rod, the horizontal movement varying in speed, though the wheel to which it is attached revolves uniformly. If the sprocket wheel makes ten revolutions per minute, these alternations of the chain speed occur 140 times per minute, and are necessarily fatiguing and destructive to the chain, producing a violent increase of the normal strain at frequent intervals without any useful result.

The equalizing gears are designed to impart pulsating motion to the driving sprocket wheel exactly counteracting the variations in chain speeds above explained, and this is accomplished by making the pitch diameter of the spur wheel conform to a wave line, the number of elevations and depressions in this line corresponding with the number of sprockets of the chain wheel, and driving the spur wheel with an eccentric pinion as shown in the cut, the sprocket wheel and spur wheel being keyed on the head shaft in proper relative positions.

A series of exhaustive tests has developed the facts stated and proved the value of this gearing. By its use less power is required and the destructive strain due to driving with circular gears is eliminated, thus permitting installations of greater lengths or the use of lighter chains.

The above described inventions mark a distinct advance in the application of modern methods to the handling of materials.

Why a Fly-Wheel Burst.

The following editorial in *The Electrical Engineer* of the 9th ult., explains the cause of the bursting of a fly-wheel in a clear and rational manner:

"The bursting of a fly-wheel and partial wreck of the Hudson Electric Light Co.'s station at Hoboken, N. J., points a lesson which may well be impressed upon those in charge of central stations. It seems that a short circuit on the line had blown the fuses, and during their replacement the engineer had slowed down the speed of the engine by raising and holding up the governor. The new fuses had no sooner been replaced, however, when they blew again, and the engineer becoming "rattled," in order to slow the engine down again, held the governor down. The result was natural, and the engine raced until the fly-wheel burst. The unfortunate engineer paid with his life the penalty of his carelessness. But it seems hardly credible that anyone should take such a means of reducing an engine's speed, instead of shutting off the steam at the valve."

The fly-wheel was on an engine built by the Philadelphia Engineering Co. of Philadelphia. That the accident was not due to any fault in the construction of the wheel is evident from the above editorial and the fact that the Hudson Electric Light Co. ordered the Philadelphia Engineering Co. to replace the broken wheel with one exactly like it.

Interesting Books.

"Cableway Sketches" and "Contractors' Methods employed on the Great Chicago Drainage Canal" are the titles of two very interesting illustrated pamphlets issued by the Lidgerwood M'f'g. Co. While primarily published to advertise Lidgerwood engines and cableways, they are of broader scope than mere trade catalogues. The illustrations are attractive and the text is full of valuable pointers to engineers, mine owners and mine officials. They are sent free on request to the Lidgerwood M'f'g. Co., 96 Liberty St., New York.

Large Boiler Sales.

Messrs. H. E. Collins & Co., Pittsburg, Pa., Sole Sales Agents for the Cahall Vertical Water Tube Boiler, manufactured by the Aultman & Taylor Machinery Co., Mansfield, Ohio, advise us of the following sales of Cahall boilers within the past ten days:

Mahoning Valley Iron Co., Youngstown, Ohio, second order 300 H. P.; Sharon Iron Co., Sharon, Ohio, second order 500 H. P.; Phoenix Glass Co., Pittsburg, 75 H. P.; Citizens' Gas Co., Bridgeport, Ct., 330 H. P.; Isaac Harter Milling Co., Fostoria, Ohio; Hainsworth Steel Co., Pittsburg, 500 H. P.

INGENIOUS MINING CONTRIVANCES.

This department is intended for short and plain descriptions of unpatented ingenious contrivances or methods used at mines and found of value. When necessary, articles will be illustrated with cuts, if the writer will send a clear pencil sketch from which our artists can make the necessary drawing.

If the ideas are clearly expressed we will make all needed corrections in composition.

All accepted articles will be paid for at the rate of $5.00 per column, payable in any books in our catalogue, or that of any other publishers.

An Automatic Switch.

By J. J. Ormsbee, E. M.

At the Westmoreland shaft of the Westmoreland Coal Co., near Irwin, Westmoreland county, Penna. some years ago, an accident occurred from a car of slate running into the shaft. The surface arrangements were about as indicated in the diagram, Fig. 1. The loads were run from the shaft to the tip by gravity. The empties and slate cars were carried up grade from *A* to *B* by means of an endless chain, the incline hoist being driven from the head-frame sheave. From the knuckle

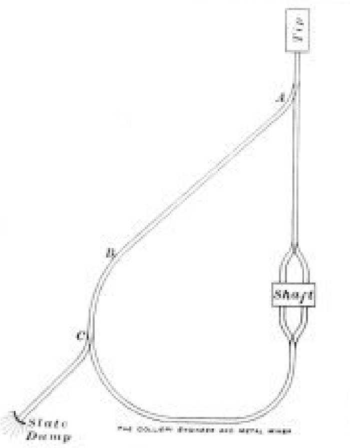


Fig. 1.

at *B* the cars ran by gravity to the shaft, or to the slate-dump *via* the switch at *C*, as the case might be. The accident was due to a wrong setting of this switch; and to guard against any repetition of it, Mr. Robt. Ramsay, then Supt, devised an automatic switch that gave full satisfaction. It has not, to the writer's knowledge, been described in print heretofore, although its simplicity and ingenuity would warrant it.

The sketch, Fig. 2, shows its main features. To the the two bridles near the ends of the switch-rails were fastened small rollers, as shown. The bridles were prolonged and connected to a rocker shaft, to which a counter-weight was attached. The rails leading to the slate-dump were depressed below the level of those leading to the shaft, and the stringers underneath the switch-rails were made with a bevel so as to bring these rails to the right level for the slate track when the switch was thrown for it. Plates of iron were inserted in the paths of the rollers. The counter-weight was so adjusted that

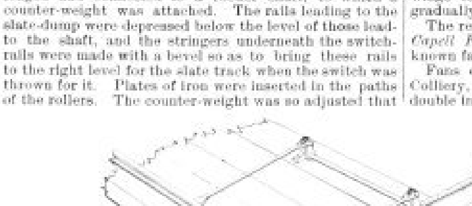


Fig. 2.

when an empty car came along, the switch remained in its normal position as shown in the sketch, allowing the car to go to the shaft. But the weight of a loaded car caused the switch to move down the inclined plane, raising the counter-weight. Immediately after the passage of the car this weight, acting though the rocker shaft, brought the switch to its normal position. So well was it balanced and so nicely did it work that a heavy man in an empty car would throw the switch to the slate-dump.

Compressed Air Locomotives.

We are informed by Messrs. H. K. Porter & Co., of Pittsburgh, Pa., that their compressed air mine locomotives are meeting with such favor that they are now building four for different parts of the country.

Written for The Colliery Engineer and Metal Miner.

THE CAPELL FAN.

An Interesting Account of the Invention and Subsequent Improvement of this Wonderfully Efficient Mine Ventilator.

Great inventions, like great discoveries, are sometimes made in seeking for some other thing. The ventilation of coal mines, was not in the mind of the Rev. G. M. Capell, rector of Passenham, Stoney Stratford, England, when he made a fan after his own fancy. To dry hay, was the work for which he designed it. In his case, necessity was truly the mother of invention. Season after season, the glebe hay crop had been spoiled by the peevish persistence of St. Swithen, the patron Saint of wet weather, a mouthful of sweet hay had become a very scarce article in the rectory hay mow; when Mr. Capell conceived the idea of putting his *green* hay under cover, and drying it by blowing fresh air through, thus removing the risk incidental to exposure in the open fields, in the climate of England.

With the village blacksmith, as executive, and the parson, with his physics and mathematics, as designer, was produced, the germ from which the present fan grew.

In 1893–1894 Mr. Capell succeeded in making great improvements in the power of his fans. He placed the the inner wings at an angle, causing the air to be driven screw-propeller fashion into the fans body; he then formed the ends of these wings in the inlet into a scoop of special form, the portion nearest the center (or at point of slower motion) presenting a larger collecting surface than that near the junction of inner and outer wings to which the inner wings set on an incline and gradually lead up the air.

The result has been to increase the power of the *New Capell Fan* an average of 30% compared with well known fans of the earlier patent.

Fans on this system are now at work at Garswood Colliery, Wigan, England, 17 ft. 6 in. diameter, double inlet, capacity 450,000 cubic feet per minute and 6 in. water gauge. Two at Allerton Main, Yorkshire, 12½ ft. double inlet. One at Hutton Henry Colliery, Wingate, Durham, England, and at about 20 other places in Great Britain, Germany, Belgium and France.

One fan 13½ ft. diameter and 5 ft. wide, at Sanquhar Colliery, Scotland, gave 100,000 cubic feet of air per minute and 1 in. water gauge at 80 revolutions.

The table below shows the performance of two fans each, of new and old construction.

The American fans built under this patent have hitherto beaten the best British and German practice, as was shown in our last issue, when we give the record made by a Capell fan at the Youghiogheny Coal Co.'s No. 1 Mine, at Scott Haven, Pa. This is a single, eight foot fan, it runs at 208 revolutions per minute and exhausts from a mine having about two miles of entries and workings through which the air traverses. It

OLD CONSTRUCTION. Stanton Colliery, Mansfield, England		NEW CONSTRUCTION. Allerton Main Colliery, Yorkshire, England	
Diameter	12½ ft. } 2 inlets	Diameter	12½ ft.
Width	11 ft. } 2 inlets	Width	10 ft.
Revolutions per min.	215	Revolutions per min.	215
Water gauge	4 1ins	Water gauge	4.5 ins
Cu. ft. air per min.	190,500	Cu. ft. air per min.	240,000

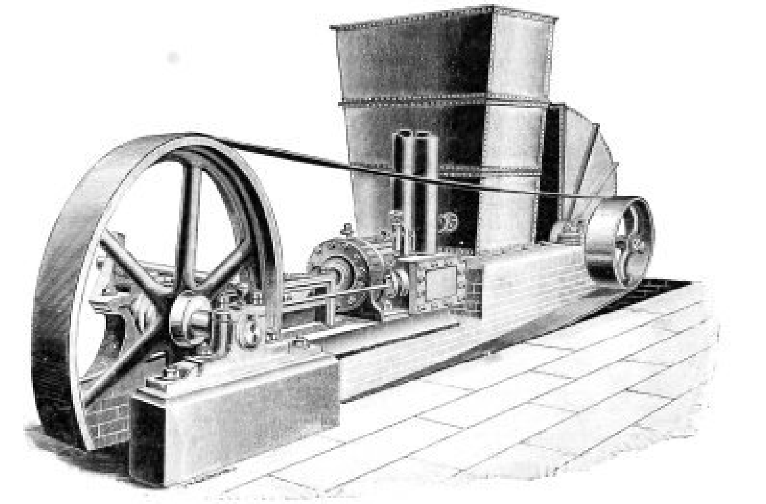
Old Construction Fan at Digby Colliery, Nottingham, England.		New Construction Fan at Hutton Henry Colliery, Wingate Durham Co., England	
Single Inlet, dia.	15 ft.	Single Inlet, dia.	15 ft.
Width	5½ ft.	Width	5½ ft.
Revolutions per min.	220	Revolutions per min.	220
Water gauge	6 ins.	Water gauge	6.14 ins
Cu. ft. air per min.	140,000	Cu. ft. air per min.	216

develops a water gauge of 1 inch and passes 85,000 cubic feet of air per minute. It was guaranteed to pass 65,000 cubic feet of air at 325 revolutions, so that it is doing about 30% more work at less than ⅔ speed. So that the guarantee of Mr. Wm. Clifford, the sole licensee and manufacturer was certainly a conservative one.

Mr. James Blick, Inspector of Mines for the Seventh Bituminous District of Pennsylvania, sends us the following results of a test of a Capell fan, at Moon Run Mine in the Pittsburg district:

The fan is 8 feet in diameter and 7 feet wide with two inlets. In drawing air from the mine it was run at a speed of 208 revolutions per minute, developed a water gauge of 1.1 inch and produced a current of 108,000 cubic feet of air per minute. After carefully checking this test, the mine was sealed off, and no air passed to the fan. It was then run at the same speed, (208 revolutions per minute) and developed a water gauge of 2 inches. It will be noticed that when the mine was sealed off and the fan was passing no air the water gauge was doubled. In noting these figures, Mr. Blick says:

"I have tested other types of fans under similar conditions to the above and found the W. G. to be practically the same, when passing air from the mines and

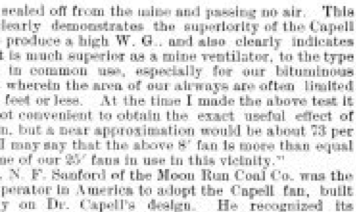


Capell Fan, Driven by Belt from Engine.

when sealed off from the mine and passing no air. This fact clearly demonstrates the superiority of the Capell fan to produce a high W. G., and also clearly indicates that it is much superior as a mine ventilator, to the type of fan in common use, especially for our bituminous mines wherein the area of our airways are often limited to 40 feet or less. At the time I made the above test it was not convenient to obtain the exact useful effect of the fan, but a near approximation would be about 73 per cent. I may say that the above 8' fan is more than equal to some of our 25' fans in use in this vicinity."

Col. N. F. Sanford of the Moon Run Coal Co. was the first operator in America to adopt the Capell fan, built strictly on Dr. Capell's design. He recognized its strong features as soon as he saw the shape of the inside of the fan.

It is claimed that in this fan, the energy of centrifugal force is practically undiminished by impact against non-energizing surfaces, and that its lines allow of the free



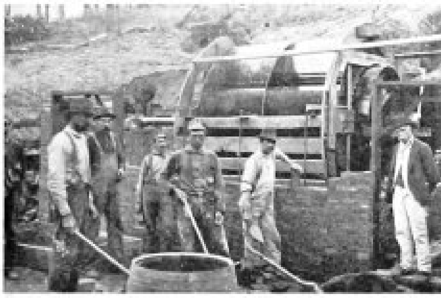
Capell Fan, Showing Latest Improvements.

flow of fluids in accordance with those well-known laws which govern them.

The Capell fan has been the subject of severer criticism than usually falls to the lot of inventions so intimately affecting coal mining. The asperity of British criticism arose in the main from professional prejudice against the manner in which the fan was first described in mining papers, its force being principally directed against such statements put forth in Wm. Capell's name, as that the fan gave 129 per cent. of mechanical efficiency, as the result of numerous and repeated experiments by eminent mechanical engineers.

This controversy was noticed in The Colliery Engineer and Metal Miner at the time, and to many of our readers is ancient history. But it was not until 1888, that the seeming paradox was lucidly and scientifically explained, by Monsieur H. Bochet, Chief Inspector of mines, Paris.

More recently, experiments were made by a Belgian Commission on fans; with the Rateau, Capell and other fans, in which the Capell was given a poor place. In nearly every foreign exchange which reached us, the facts that the commission was a commission of one person, and that he was the engineer to the owners of the Rateau patent was not stated. So that we welcome the advent of the Capell fan in America, where our own experts can see it and test it for themselves.



Capell Fan in Course of Erection at Moon Run, Pa.

This fan is driven by belt or other rope like most other important ventilation installations abroad built during the last 10 years. But we think with the so many durable and quick running engines to choose from here, and the freedom from prejudice on part of our engineers and operators, direct driving will in many cases be adopted.

A Mine Foreman Killed.

Mr. Thos. West, mine foreman at No. 3 Mine, Sherodsville, Ohio, was instantly killed on the first ult., by the explosion of a dynamite blast in the bottom of an air-shaft. He was at work in a hole being driven from the mine to meet the shaft. Through a mistake in instructions the men sinking the shaft fired a shot which broke through and caused the sad accident. Mr. West was born at Cammerton, Somersetshire, England on May 3, 1866. As a boy he attended the public schools. Though compelled to earn his livelihood in the mines at an early age, he was ambitious to secure a technical education. At the age of 19 he took a special course in mining under Mr. Wm. Tate, then editor of *Science and Art of Mining* at Wigan, England, and now assistant editor of The Colliery Engineer and Metal Miner. After completing this course, he successfully passed his examination and received a certificate of competency as a mine manager from one of the British examining boards. Mr. West came to America in the fall of 1892, and soon became foreman of a mine at Dell Roy, Ohio. In February of this year, he resigned that position to accept the foremanship of the mine in which he lost his life. He was a man of most excellent habits, and a close and constant student. Had he not been cut off in his early manhood, his industry and study would eventually have resulted in his attaining a high place in the mining industry. Mr. West is survived by a widow and two small children.

A Large Air-Compressor Plant.

The Ingersoll-Sergeant Drill Co. has just received a large order for a complete plant of air-compressing machinery for running drills, engines, pumps, etc. on the Jerome Park Reservoir work, New York.

The contract for the construction of the reservoir was awarded to Mr. J. B. McDonald at $5,473,060. It involves the removal of upwards of 3,000,000 cubic yards of rock. The contractor has since the letting of the work made a thorough investigation looking to a determination of the question whether or not machinery for excavation can best be run by steam, or from a central compressed air plant. The central plant system has been adopted as the best and cheapest, the saving in expense being largely in labor and fuel.

The plant made by The Ingersoll-Sergeant Drill Co. and adopted by the contractor involves the use of compound condensing Corliss air-compressors run by high class boilers transmitting and distributing compressed air at 80 pounds pressure throughout the work.

It is contemplated to use a battery of several air-compressors placed side by side, the unit adopted being a duplex compressor with steam cylinders 24″ & 44″ in diameter, stroke 48″, driving two piston inlet air cylinders each 24¼″ in diameter by 48″ stroke, the capacity in free air of this machine being between 3,000 and 4,000 cubic feet per minute. This is a duplicate of the compressors at work at the Anaconda Mines in Montana where very economical results have been obtained.

Cahall Boilers.

Messrs. H. E. Collins & Co., Pittsburgh, Penna., sole sales agents for the Cahall vertical water tube boiler, manufactured by the Aultman & Taylor Machinery Co., of Mansfield, Ohio, have opened a branch office in the Havemeyer building, New York City, for the sale of Cahall boilers for that district in charge of Messrs. Wm. R. Sattler & Co. Mr. Wm. R. Sattler is an engineer of national reputation, having been for some time at the Brooklyn Navy Yard and Mr. Geo. C. Tewksbury the other member of the firm, is well and favorably known throughout the New England and Eastern territory as a very successful salesman in the line of engines, boilers and general mill machinery, and Messrs. Collins & Co. are fortunate in having secured their services.

Collins & Co. also advise us that they are now shipping the second lot of boilers on the order for 10,000 H. P. from the Apollo Iron & Steel Co. for their new mill at Vandergrift

WATER-POWER IN MINING SERVICE.

A Solution of the Problem of Regulation.

A problem which confronts every prospective user of water-power—and not a few actual users of it—is the regulation of it to secure constant speed of the machinery driven, under the inevitable changing conditions of load and water pressure.

This problem assumes serious proportions when electrical generators, in turn driving other machinery, are to be operated. For in such cases not only the efficiency of the plant, and the quality of product are to be considered, but sudden changes of speed materially effect the life of the machinery.

Knowledge of these facts and lack of knowledge of means for overcoming the troubles named, in fact, until within a very recent period, lack of such means, has prevented attempts being made to utilize what in many instances, are highly valuable water-powers. But with the recent accomplishments in the transmission of electrical energy over long distances, and in the use of compressed air, the utilization of water-powers at points far removed from the necessary location of the power plant proper, is receiving serious thought in many places, and, here and there, practical application.

It is probable that in no part of the world will better examples of engineering progress in this direction be seen than in the mining districts of the Rocky Mountains in the United States. Here the conditions are in the highest degree favorable to the development and utilization of water-powers, once the solution of the problems of transmission and regulation is demonstrated. High cost of fuel, and often scant supply of water for steam purposes at the exact location where power is needed, on the one hand, and an abundant supply of water under high head for power purposes, one to fifteen miles distant, on the other hand, are conditions which frequently prevail in this region, and which any live mine manager cannot look upon, at least should not look upon, with indifference.

It is perhaps not too much to say to submit that there are to-day mining and milling properties in the Rocky Mountains, barely paying expenses if not doing worse, which by a thorough revamping of power plant along the lines of modern approved engineering practice would become dividend-paying propositions.

The matter of transmission of power, either electrically or by compressed air has now reach a very satisfactory stage. The loss or "drop" can be calculated almost to a nicety and the plant designed accordingly. The advance within the last few years has been rapid but no less certain and successful, until to-day, profitable examples of power transmission up to fifteen miles are not unknown. Some installations of much greater magnitude have been made, with more or less success, and been attended with a great amount of hurrah, but these for the most part do not greatly concern the mining engineer. The cases will be few and far between where if water power can be utilized at all at a profit it cannot be reached within fifteen miles, and it is not unlikely that a ten mile radius will be found to encompass the large majority of plants of this type. Put another way, it may be safely said that if all the mining properties which have water power within ten miles profitably available were now utilizing it, there would to-day be an unprecedented demand for hydraulic, electric, and compressed air equipment.

Within the past two years as great advances in the matter of governing water power have been made as in the transmission of power thus generated, though the success of such efforts has not been so widely heralded. A water power regulator which has met a very favorable reception and which probably has been installed in more plants than any other, is shown in the accompanying illustrations. It is known, from its inventor, as the Replogle governor, and is made by the Replogle Governor Works, Akron, Ohio.

The Replogle water-wheel governor consists essentially of a regulator. (Fig. 1), a high speed engine governor (Fig. 2), and a gravity battery with its circuit (Fig. 3). The electric circuit indicated in Fig. 3 is that used in what is known as the "Compound" governor for service under severe and sudden changes of load, such as electric railway or power equipment.

The speed governor (Fig. 2) is belted to the shaft to be governed, and a rise or fall in the speed causes a corresponding rise or fall in the lever *B*. The lever *B* is a part of the battery circuit and in rising makes or completes the circuit at *C*, energizing magnet 4 (Fig. 1) which causes an engagement of its pawl, and through such pawl turns a shaft (the large shaft shown in the front in Fig. 4) directly connected with the water-wheel gates, and causes such gates to open. An opposite variation in the speed causes the other pawl likewise to act, and closes the gates.

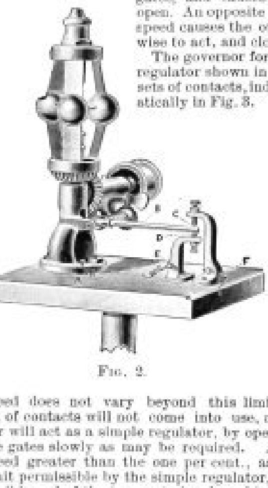


Fig. 2.

The governor for the compound regulator shown in Fig. 4 has two sets of contacts, indicated diagrammatically in Fig. 3. The small lever has a flexible tongue attached to its free end and the extreme end of this tongue has a second set of contacts. The contact points being adjusted so that the outer ones make their circuit at one per cent. variation in speed, if the speed does not vary beyond this limit the second set of contacts will not come into use, and the governor will act as a simple regulator, by opening or closing the gates slowly as may be required. A variation in speed greater than the one per cent., assumed as the limit permissible by the simple regulator, will cause the flexible end of the tongue to bend, making a second contact, and throwing into action a second set of magnets, thus doubling the gate motion. This second set of magnets may be brought into action at any desired variation greater than the first, and may be used as a safety against great changes of load.

The builders of this governor make one hint to users of water power which will apply equally well to any regulator. The gate rigging should be in good order, but it should *not* be exactly balanced; it should have a constant tendency to close at all points of gate opening. The point in this is to prevent back lash of intermediate gearing. If the pressure is always one way there can be no lost motion. Another matter of importance is to have the proper speed for the head of water. It is impossible to govern a wheel that is running too slow, and besides it is wasteful of water. A wheel that runs too fast will waste some water, but it will govern all the better for its excess of speed. This however is a matter for water wheel manufacturers to give information about, and each such will determine the proper speed for any given wheel to attain best results.

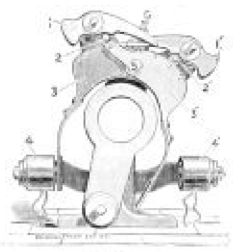


Fig. 1.

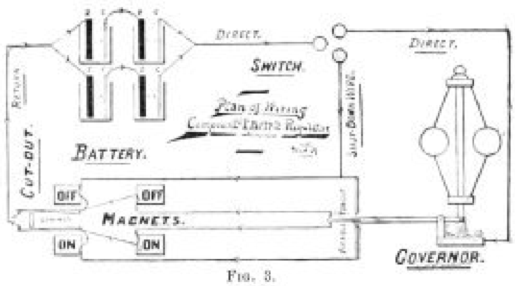


Fig. 3.

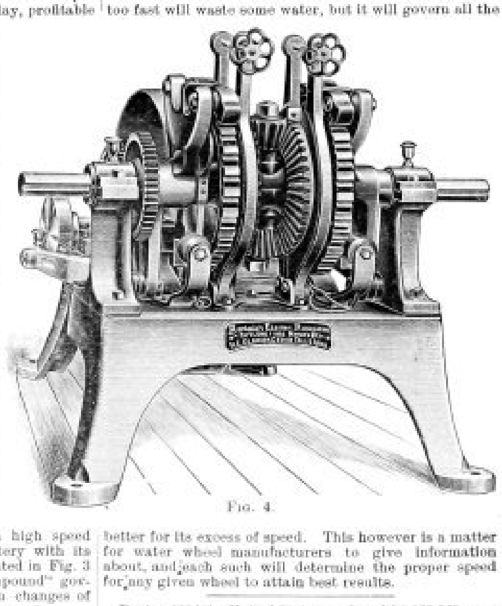
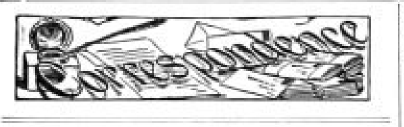


Fig. 4.

During 1894 the United States produced $6,829,260 more gold than silver, taking silver at its commercial valuation.



This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.*

Questions on subjects not directly connected with mining will not be published.

Hoisting.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following questions in your valuable paper for some of the readers to answer.

1. There is an engine located at the Merrian Colliery which has double conical drums which are 12 feet on the big end and 10½ feet on the small. The two first motion engines have a five feet stroke and 24 inch cylinders. The slope is 315 feet deep and pitches at 65°, and has a two inch rope. Why is it that the tar does not stay on the drum 18 inches from the big end and it stays on the rest of the drum? It flys off about a foot wide on the floor and does not come off the rest of the drum.

2. I am running an engine which has a drum 12 feet in diameter and has a 2 inch rope. The rope has two gunboats on and one dumps 5 feet higher than the other. How will I take the slack up.

Yours etc.,

Mt. Carmel, Pa. P. S.

Pumping.

Editor Colliery Engineer and Metal Miner:

SIR:—Will some correspondent please give a simple rule for determining the size of steam pump necessary to pump 30,000 gallons of water per day from a mine where the vertical lift is 160 yards. The steam pressure at the boilers on the surface averages 90 lbs. per sq. in. and the pipe which is covered with asbestos covering runs on the surface for 56 yds. then down the shaft 160 yds., and then 8 yds. to the pump? What size steam pipe and what size column pipe should be used? Also will a separator placed in the steam pipe near the pump permit of the use of a cheaper plant than if there is no separator.

Yours etc.,

ASS'T. SUPT.

Oct. 11, 1895. Nelsonville, Ohio.

How to Mine.

Editor Colliery Engineer and Metal Miner:

SIR:—Will you please publish the following question in the next number of the COLLIERY ENGINEER AND METAL MINER for answer: I am mining a 6 foot seam of splint coal which is located 38 feet under another seam 8 feet in thickness, the parting being 2 feet of coal and slate as roof of lower seam, and 36 feet of hard sandstone (Lower Freeport). How will the upper seam be affected if the lower one is mined out on the stall and pillar system and the room pillars drawn?

Yours etc.,

INQUISITIVE,

Oct. 6, 1895. Mammoth, Kanawha Co., W. Va.

Surveying.

Editor Colliery Engineer and Metal Miner:

SIR:—I am working a seam of coal that outcrops on a piece of land which I cannot enter. The horizontal distance of the land line from the high side of the gangway is 110 ft. I have driven a hole up on a pitch of 34° for 53 ft. from the high side of the gangway and at this point the pitch changed to 57°. I have driven on this last pitch a distance of 56 ft. How much farther can I go on the same pitch before I reach the land line.

Yours etc.,

TOM,

Oct. 22, 1895. Minersville, Pa.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Will some of your contributors please answer the following question: What is the best method of removing the smoke from a tunnel 7 ft. wide 6 ft. high and 630 ft. long, running into a mountain? The truck or car used in taking out the rock requires a space 4½ ft. wide and 4 ft. high.

Yours etc.,

JOHNSON,

Oct. 12, 1895. Durango, Col.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—I notice in your July issue that Joseph Virgin, of Holsopple, Pa. gives the following rule to find the total quantity of air in a ventilation question which was asked at a recent Nova Scotia examination.

$$\sqrt[3]{\frac{a^3}{s}} : \sqrt[3]{\frac{a^3}{s}} :: 50{,}000 : x$$

$$\text{or } \sqrt[3]{\frac{30^3}{220{,}000}} : \sqrt[3]{\frac{91^3}{242{,}000}} :: 50{,}000 : 147{,}474$$

cubic feet.

Now the question asked was: Suppose that by a given power 50,000 cubic feet of air per minute pass through an airway, 6 × 5 feet in section, and 10,000 feet long, and that a change is made by dividing the current into three splits of the following dimensions:

First 6 × 6 feet, 4,000 feet long.
Second 5 × 6 feet, 3,000 feet long.
Third 5 × 5 feet, 4,000 feet long.

What quantity of air will pass through each of the splits that are now substituted for the original airway the power remaining the same?

ANS. Now, to clearly analyze the question and prove the answer correct we will first find the actual units of work done, which will be found from the following formulas. The coefficient used is the one recommended by THE COLLIERY ENGINEER AND METAL MINER some time ago.

$$P = \frac{k\,s\,v^2}{a} = \frac{.00000001 \times 10{,}000 \times 22 \times \left(\frac{50{,}000}{30}\right)^2}{30}$$

= 203.70374 lbs. pressure.

$W = P\,Q$ ∴ 50,000 × 203·70374 = 10,185,187 units of work.

For a constant quantity of air with equal lengths of airway, with any change that is made in sectional area and surface, then the pressure per square foot would be in ratio to surface, and to the square of the velocity, and in inverse ratio to sectional area. Now the pressure per square foot $= \frac{s\,v^2}{a}$ and from the following relative figures we get the following relative pressure and power because power increases at the same rate as pressure with constant quantity.

$$\left(\frac{3 \times 30}{91}\right)^2 + \left(\frac{1 \times 91}{30}\right)^2 = 9.30334568.$$

The lengths are as 10 and 11, and they must act in an inverse ratio ∴ $\frac{9.30334568 \times 10}{11} = 8.457587$ and for the three airways the relative pressure and power is as follows:

8.457587 × 3 = 25.372761, and relative quantity = $50{,}000 \times \sqrt[3]{25.372761} = 146924$ cubic feet.

From $P = \frac{k\,s\,v^2}{a}$ we find pressure to be as follows:

$$\frac{.00000001 \times 242{,}000 \times \left(\frac{146{,}924}{91}\right)^2}{91} = 69.32289 \text{ lbs.}$$

pressure.

Units of work = 146924 × 69.32289 = 10,185,196.

Now from the terms of the question, the pressure in the three airways must be the same instead of the power, but the total power must be constant, and having got one relative pressure we must find the other from the following rule $\sqrt{\frac{a}{s}} \times a$.

Then,

$$\sqrt{\frac{36 \times 3}{24 \times 4}} \times 36 = 38.18376 \text{ for first airway.}$$

$$\sqrt{\frac{30}{22}} \times 30 = 35.03245 \text{ '' second ''}$$

$$\sqrt{\frac{25 \times 3}{20 \times 4}} \times 25 = \frac{24.20614}{97.42235} \text{ '' third ''}$$

The pressure being constant for the three airways, it is only neccessary to get the quantity and pressure in one airway, and we will use the second one:

∴ 97.42235 : 35.03245 :: 146924 : 52833 nearly.

$$P = \frac{k\,s\,v^2}{a} = \frac{.00000001 \times 66000 \times \left(\frac{52833}{30}\right)^2}{30} = 68.2324.$$

Having obtained the two relative pressures we get the total quantity as follows:

$$\sqrt{\frac{69.32289}{68.2324}} \times 146.924 = 147702.6 \text{ cubic feet.}$$

And from $\sqrt{\frac{a}{s}} \times a$, we get the quantity in each airway.

97.42235 : 38.18376 :: 147702.6 : 57890.63
97.42235 : 35.03245 :: 147702.6 : 53113.00
97.42235 : 24.20614 :: 147702.6 : 36698.97

147,702.60 cubic feet.

Taking second airway for pressure we have,

$$P = \frac{k\,s\,v^2}{a} = \frac{.00000001 \times 66{,}000 \times \left(\frac{53{,}113}{30}\right)^2}{30} = 68.9575.$$

Units of work = 147702.6 × 68.9575 = 10,185,202.

Joseph Virgin will see from this that his answer is entirely wrong.

Yours etc.,

THOMAS SHAW.

Jenny Lind, Ark., Oct., 1895.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—I shall be greatly obliged if some of your correspondents will inform me why most fans are run by belts instead of direct connected engines?

Yours etc.,

JOHN K.

Oct. 3, 1895. Edwardsville, Pa.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for November.

QUES. 187. I am still busy with the invention of our proposed new safety lamp, and I still crave for a little of your assistance, which I have no doubt you will cheerfully give by answering the following three questions:

1st. What should be the diameter and length of the gauze cylinder if I use one; or if I use two, as is done in the case of the Marsaut, what would be the best dimensions for each of them, and give reasons why you prefer the sizes you name?

2d. What should be the sizes of the wires and meshes of the gauze, and how many lines should there be to the linear inch?

3d. What is the use of the bonnet or close shield, and should we adopt one in our new lamp?

QUES. 188. We are going to try some experiments by exploding fire-damp in a close, strong vessel, made of steel, and strong enough to resist the greatest pressures to which it may be subjected. The fire-damp is a diffusion in which 10 volumes of air are saturated with one volume of marsh-gas. To the steel vessel we are going to attach a pressure gauge, and I will feel obliged if you will tell me what the pressure will be at the moment of the explosion and after the steel shell and its contents or remaining gases have cooled down to the present or actual temperature of the outside air?

QUES. 189. We have on hand a ventilating fan that can discharge 120,000 cubic feet of air per minute, with a useful effect of 30 H. P. We are going to sink two rectangular shafts, whose lengths have to be twice their breadths and their areas have to be equal. One of them will be an upcast and the other a downcast for the ventilation, and to prevent a needless waste of energy we wish the shafts to be of such an area that only one-third of the ventilating power, or 10 H. P., shall be necessary to overcome the friction of the shafts. Will you, then, calculate for us the area and the length and breadth required for each shaft?

QUES. 190. We have two airways which we will call A and B, and they are both 2,000 yards in length, and the air is blown through each of them with a difference of potential equal to 2 inches of water gauge. A, however, is 10 feet wide and 6 feet high, and B is 15 feet wide and 10 feet high, and as we do not require more air to pass through B than through A, will you find what quantity is passing along A, and what should be the area of a regulator in B to pass the same quantity as that of A; the *vena contracta* being taken at .65, and k at .00000001.

QUES. 191. An important vein of iron-stone is outcropping on a hillside, and I will be obliged if you will calculate for me its height above a point we will call A. To reach the outcrop, the nearest course is to descend from A to B and then ascend to C, and from C ascend the hillside to D. Now D at the point A makes an angle of elevation of 29° 3′. The distance from A to B is 91 feet, and B makes an angle of depression at A of 26° 26′. The distance of C from B is 125 feet, and C at the point B, makes an angle of elevation of 18° 26′. The distance of D from C measured up the side of the hill, is 240 feet. What then is the vertical height of D above the level of A, when the points A, B, C, and D all lie in the the same vertical plane?

QUES. 192. What would occur if the force pumps for feeding a boiler were set at an elevation of 5 feet above the level of the feed water in the heater when the temperature of this water was 212° F.

Answers to Questions which Appeared in September and Previous Issues, and for which Prizes Have Been Awarded.

QUES. 175. There is at present a ready market and a good price for fire-bricks; flooring tiles for fire-proof buildings; common bricks for filling and backing; glazed and unglazed facing bricks; sewer pipes and drain traps.

Our Coal Mining Company wish to share in this manufacture and trade, and have desired me to make sample bricks out of the underlays of five different coal seams we are working. I have done so with the following results. Clay of seam A makes a hard strong red brick coarse in the grain; clay of seam *B* contains iron balls, but the dressed clay makes a soft white brick that is very porous; clay of seam *C* makes a soft white brick that is very porous and speckled with blackish brown spots; clay of seam *D* makes a hard coarse grained brick, and of a black and bluish color; clay of seam *E* makes a white brick that is very strong and fine in the grain. Now I desire to know two things to enable me to make a satisfactory report to the company.

First. What classes of goods are each of the clays best adapted for making?

Second. What are the constituents in the clays that give to the bricks their different characteristics?

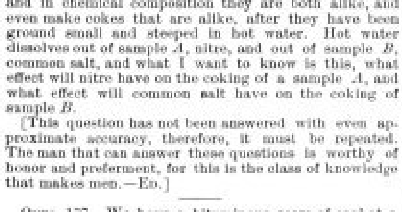
[We are sorry to say this question has not been satisfactorily answered and let us give a hint to those of our w'se competitors, that are thriving for advancement in their profession or intended profession of mining. That such knowledge as is required to answer this question is of the right character to promote its possessor. Numerical questions and answers are of great value but without a substantial knowledge of chemistry, mineralogy, geology and practical mining, mere figure knowledge is of no account.—ED.]

QUES. 176. Here are two samples of bituminous coals, and in chemical composition they are both alike, and even make cokes that are alike, after they have been ground small and steeped in hot water. Hot water dissolves out of sample *A*, nitre, and out of sample *B*, common salt, and what I want to know is this, what effect will nitre have on the coking of a sample *A*, and what effect will common salt have on the coking of sample *B*.

[This question has not been answered with even approximate accuracy, therefore, it must be repeated. The man that can answer these questions is worthy of honor and preferment, for this is the class of knowledge that makes men.—ED.]

QUES. 177. We have a bituminous seam of coal at a depth of 400 feet and lying nearly level, and we are going to work it by the system of longwall retreating. The floor is a soft shale and the roof is a slate. We will be obliged if you will give us a map of the best plan of working, together with all the necessary explanation.

ANS. I would work the coal on the principle of the accompanying plan and make the heading pillars from



150 to 200 feet and would advance the face with brattice cloth partitions to direct the intake and return air currents.

After the east and west headings have reached the boundary line and are connected with a face road I would arrange the ventilation to properly air the haulage roads and the working face.

JOSEPH VIRGIN,

Second Prize, WILLIAM HODGE, Holsopple, Pa.
Forbush, Appanoose Co., Iowa.

QUES. 178. We find the roof of a coal seam we are working is an argillaceous lime stone, and what our neighbors call the same seam in the surrounding collieries has in some cases a slate roof, in others a sandstone roof and in others an arenaceous limestone roof. Do you think it is the same seam of coal in all the cases, and if it is, under which kind of roof will the coal be thickest?

ANS. It is more than likely that the same seam has the different covers mentioned in the question, for such differences of the roof strata occur in this state, that is, Pennsylvania, and by observation I have found the thicknesses of the seams under the different covers to vary as follows:

Thickest under calcareous shale.
Thick under argillaceous shale.
Much reduced under calcareous sandstone.
Thin under sandstone roofs.

JOSEPH VIRGIN,

Second Prize, JOHN VERNER, Holsopple, Pa.
Lucas, Iowa.

QUES. 179. I am now a fire-boss, but I am promised promotion if I can learn to level, will you therefore, show me with a sketch and an explanation how to level upgrade for 25 yards? Make the surface very uneven, and after setting up the instrument read the staff every five yards.

ANS.—

Sta.	B. S.	F. S.	H. of Inst.	Elevation.	Remarks.
B. M.	6.449		1416.500	1410.051	Nail in pine stump.
1		11.300		1405.200	
2		2.400		1414.100	
T. P.		1.976		1414.524	Top of stake 2.
	10.523		1425.047		
3		3.747		1421.300	Summit.
4		9.147		1415.900	Basin.
T. P.		0.776		1424.271	
	11.241		1435.512		
5		9.300		1426.212	
6		0.009		1435.503	

In taking levels the elevations may be "independent," that is, on any assumed height as 100, 1000, etc.; or they may be referred to some fixed point, the elevation of which, above tide water has been previously determined.

In the present case we will suppose that a fixed point or "Bench Mark" is located between the two first stations of our line and its elevation is 1410.051 ft. above tide level. The line is divided into stations of 5 yards each which for convenience are called 1, 2, 3, 4, 5 and 6. The staff or rod used is a 12-ft. sliding rod reading to the thousandth part of a foot.

First, place the instrument in any convenient location being careful not to have it more than 12 ft. above the surface at station 1. It need not be necessarily on the line. Then with the rod on the B. M., take the reading 6.449 and write it in the column marked "Back Sight." This reading added to the elevation of the B. M. gives the first "Height of Instrument." Move the rod to station 1 and read 11.300 which is the first "Front Sight."

Subtracting front sight readings from height of instrument gives the elevations of the points corresponding to to the readings. With the rod at station 2, the reading on surface is 2.400, a front sight.

It is plain to be seen that the instrument must be placed higher in order to see station 3, but before moving it, take a reading on some solid, well-defined point, as for instance, the top of a stake, and call it a "Turning Point." Now move the instrument up the hill, taking care to be less than 12 ft. above the turning point, and set it near the small summit noted at station 3.

Then sighting to a rod on the T. P. read 10.523, a back sight, and take the readings at stations 3 and 4 which are lower than the instrument. Establishing a new T. P. on a stone near station 5 move the instrument once more and set it in a position to take the T. P. and Sta. 6.

To check the calculations find the difference between the sum of the back sight readings and the sum of the front sight turning point readings. The difference thus obtained represents the elevation lost or gained in the operation.

Second Prize, E. H. BAILEY, E. M. PORTER,
Rock, W. Va. Eckley, Pa.

QUES. 180. The action of one of our mine pumps is very peculiar, and it will startle you when I tell you, that any increase above a certain speed of the piston reduces the lifting power of the pump, and at another increase of speed the pump loses the water altogether. Now as I would like you to explain the tricks of this peculiar pump, I will give some particulars. When the pump piston is at the bottom of its stroke, it is 12 feet above the level of the supply water, and as the force to lift the keep valve and overcome the friction of the water moving through the tail of the pump is equal to a two-feet column of water, we may reason the mean lift to be 14 feet. Will you then tell me two things?

First. What is the highest speed at which this pump can be run to obtain a maximum effect?

Second. At what piston speed does the pump lose the water altogether.

[This question has not been correctly answered and must, therefore, remain open.]—ED.

QUES. 170. A wealthy land owner has just granted me a lease to mine a lignite bed 10 feet thick and making an angle 70° with the plane of the horizon. The lease confers on me the right of way and the power to utilize any of the surface or underlying strata. The surface is on a bed of sand 20 feet thick and at first sight that would appear to be an unfavorable condition, but the lignite coal is good, and can secure an open market at a high price; we have however certain difficulties that must be overcome in the mode of working; for example, this coal is exceedingly subject to spontaneous ignition, and any small in the gob, or pillars left in, takes fire as soon as subjected to increased pressure. Therefore we must extract the *whole* of the coal, and I wish you to instruct me how to do it with the use of very little timber, at a small cost per ton, and with safety to the miners. To secure a good plan, think over all the modes of *vein* and *bed* mining in general use.

ANS. This lignite bed will require special treatment and I would work it on the filling system, using the surface sand for the filling material, and this could be sent into the mine by a pipe line, a six-inch pipe would run sufficient filling with a good supply of water, if the bottom gangway along the strike, is situated above the drainage level. The sand could be supplied to the pipe line with a steam shovel and conveyor, and the gob would be filled as the coal was removed, and as none of the coal face would be long exposed, the spontaneous ignition of the lignite would thus be prevented.

JOSEPH JAMES, 1014 North Street, Tacoma, Wash.

Immense New Turbine Plant.

Four new turbines for Niagara: The Niagara Falls Hydraulic Power and Mfg. Co., have recently contracted with James Leffel & Co., of Springfield, Ohio, for four of their improved double discharge horizontal shaft water wheels, to be of eight thousand (8,000) horse-power capacity, under a maximum head pressure of 218 feet, which is far the highest head, under which turbines of large capacity, have ever been applied in this country or elsewhere. These wheels will drive eight electrical generators, which will be connected direct to the horizontal turbine shafts without gears or belting; the wheels and generators all running in vertical planes. This is the second large order for turbines built by James Leffel & Co. for Niagara Falls; there being already several of this make of wheel, each of 1,200 horse-power, in daily operation in the Cliff Paper Co. Mills, located at the cliffs, near the tunnel. This water-wheel company is also building four of their Cascade wheels for one company, to be operated under seven hundred and thirty feet head, part of the power to be electrically transmitted, by connecting the wheel shaft directly to the generators. The Cascade wheel is, however, essentially and entirely different in construction and operation from the turbine, being in principle an impulse and reaction wheel. This Cascade wheel plant will have an aggregate capacity of six hundred (600) horse-power.

LEGAL DECISIONS ON MINING QUESTIONS.

Reported for THE COLLIERY ENGINEER AND METAL MINER.

An Agreement Creating Landlord and Tenant.—An agreement whereby a party had the exclusive right to mine coal under certain land for 20 years, unless the coal sooner gave out, and to use in connection with the mine five acres of the surface land to erect buildings upon, and to build and operate railroads and flow water over such land, for a certain royalty per ton of coal mined, not to fall below a fixed amount per year, payable as rent for all the privileges granted. Such agreements confer present rights; they are assignable; they are for a fixed period; they provide for an annual rental independent of the mining of coal; the right to mine the coal is exclusive in the lessees for the period fixed in the lease; the rent or royalty is by express terms payable for all use of the surface of the land, as well as for other privileges specified, and for coal mined. In principle, the rights granted are not different from those where one leases a stone quarry or sand bed or the like. The fact that in the one case the article taken is on or near the surface and in the other it is beneath the surface is no reason why in the one case privileges granted to take and carry away stone or sand should be held to be leases, and in the other the right to mine and carry away the coal and the valuable surface rights granted should be held to constitute a sale of the coal merely. In either case the sum stipulated to be paid, whether it be called "rent" or "royalty," is a profit issuing out of the use granted, even more so than it would be to use the land for agricultural purposes. In the latter case no perceptible quantity of the soil is taken, though the product is produced at the expense of utilizing the strength of the soil. In the former case a portion of the granted property is itself taken. This is in accord with the character of the grant, the use of the thing granted. The sum agreed to be paid is for the use of the land, upon and under the surface; and such use involves the taking away of the coal. This construction of such contracts is in harmony with their provisions, and in accord with usage touching such property; nor is it in contravention of the provision of the statute, but creates the relation of landlord and tenant within the statute, giving a landlord's lien for "rent."

Lacey v. Newcomb (Supreme Court of Iowa.) 63 N. W. Rep. 704.

Placer Patents.—The fact that a placer claim for which a patent has been issued included at the time of its location part of a lode claim, which had not then been forfeited, is a matter which cannot be considered in a collateral attack upon the placer patent; by one who has made a subsequent vein location upon part of the same land after the issuance of the placer patent.

The presumptions are all in favor of a placer patent as against a lode claim located subsequent to its issuance upon part of the same ground; and where the patentee files an adverse claim against the application for patent to the lode, and brings an action in support of such claim, the burden is upon the lode claimants to overcome these presumptions and to show by clear and convincing proofs that the vein on which the lode claim was located was a known vein at the time of the application for the placer patent.

In order that a vein or lode, included within the limits of a placer patent shall be excluded from the operation of the placer patent, under the U. S. Statutes, so as to be subject to subsequent location, such vein must have been known, at the date of the application for the placer patent to exist and to contain minerals in such quantity, and of such value and quality, as to justify, under the circumstances then existing, expenditures for the purpose of extracting them.

Montana Cent. Ry. Co. v. Mogeon (U. S. Cir. Ct.) 68 Fed. Rep. 811.

Notice of Location of Mining Claim.—Under the statute, requiring one who discovers a mining claim to file a declaratory statement of such discovery or location, on oath, describing said claim in the manner provided by the laws of the United States, the statement must be of the discovery or location, as well as of the description of the claim, and an affidavit which merely states that "the description of said lode" is true is fatally defective. The statement, in a verification of a location notice, that the locators have "fully complied with the requirements" of law, and local customs regulating mining locations, is merely a conclusion of law and does not verify any fact.

McCowan v. McLay (Supreme Court of Montana.) 40 Pac. Rep. 602.

Mining Claim.—The Supreme Court of California says: Independent of the acts of Congress providing a mode for the acquisition of title to the mineral lands of the United States, the term "mining claim" has always been applied to a portion of such lands to which the right of exclusive possession and enjoyment, by a private person or persons, has been asserted by actual occupation, or by compliance with local mining laws, or rules, or customs. The words "mining claim" as used in the law have no reference to the different stages in the acquisition of the government title. In our opinion it includes all mines, whether the title is inchoate, as in the case of a mining claim in its strict sense or perfect as in the case of a fee simple title.

Morse v. DeArdo, 40 Pacific Reporter, 1018.

Competency of Servants.—The employment as trapper in a coal mine of a boy 14½ years old, shown to be competent and careful, and who has had several years experience in various kinds of work in coal mines, is not negligence, so as to render his employer liable to a fellow servant for his carelessness.

Kansas & T. Coal Co. v. Brownlee (Supreme Court of Arkansas.) 31 S. W. Rep. 453.

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WHAT ARE OTHER MINE OFFICIALS DOING?

"WHAT are other mine officials doing?" is a question that should frequently arise in the minds of mine managers and their subordinate officials. It should be of such force as to lead them to visit other mines and find out. No one mine official in the world will be an unqualified success if he depends on his own knowledge and ingenuity only. Literature descriptive of general methods is all right in its way and is of great value in leading a mine official into lines of thought that will result in greater economies at his mine and safer plans of working, but such literature is, as a rule, too general. What makes a great improvement a success is the degree of perfection with which its details are worked out. These details can best be studied and comprehended by a personal inspection of the method of work in question. The writer during the past month visited a large colliery where, in the course of a few years, a broad minded manager increased the production nearly fifty per cent., and reduced the cost of mining and preparing coal in about the same proportion. When asked how he did it, he replied "by taking advantage of every economical device and method I had ever seen and in some instances improving on them." This manager was a man who had in his long experience visited many different collieries and gauged the methods employed at each with a practical eye. He is a reader of first-class technical literature, and this, with a faculty of discernment coupled with his practical knowledge, has made him a valuable official, and the great corporation for which he works recognizes his value in a substantial manner. No one official or set of officials can expect to produce the best results if they depend solely on their own intelligence. An occasional visit to neighboring districts or even neighboring mines will result in every instance, in gain, if the visitor is broad minded and enterprising enough to recognize the fact that other officials sometimes know points that he is unfamiliar with.

The experience of a prominent mining company in Western Pennsylvania has proved that a policy of sending an intelligent official on a two weeks' tour of inspection of the mines of other operators has proven of great value. A casual visitor to the mines of this company will instantly notice the many economical devices and methods in use. These are not the development of ideas of the officials of the company. As a rule they are adoptions of methods and devices in use at many different mines.

The writer once met the general superintendent of the company in question at a mine over a hundred miles from his own locality. The object of his visit was to look at a system of haulage in a use. After an inspection he stated that the only idea that he would use was the design of the detaching hook. His own system of haulage was equally as good, and in some respects better than that at the mine he visited, but the detaching hook, designed at the mine was just what he needed to increase the efficiency of his own plants. The time and money spent in this visit was repaid to his company many times over in the next few months. This simple incident is merely given as an illustration. Every intelligent mine official sent on an occasional similar tour will gather several such "illustrations" which when adopted will frequently embellish the balance sheet of his employer with good sized figures on the profit side.

EDUCATION A NECESSARY QUALIFICATION IN A MINE OFFICIAL.

IN a recent address, a very prominent English mining authority, whose name is familiar in every part of the world where mining is a prominent industry said: "Education conjoined with natural ability will now and hereafter be the guiding star of mining enterprise. As a proof that technical education is the key that unlocks the mineral treasures of the earth we have have only to notice the skill required in the designing and application of mechanisms that make the manual labor easier and produce better results. The application of natural forces in hydraulic mining, and the combinations of natural and mechanical forces for dressing the ores and for the separation of the metals from the baser elements all show the results of technical education coupled with practical experience. Again, ores that seem utterly worthless to the unlearned become of great value in the hands of the educated miner. The latest developments in the preparation and coking of coal, as well as the most improved methods of mining and bringing the coal to the surface, are not the outcome of practical experience only. They are the outcome of the application of technical knowledge applied by practical men.

"There is is no reason why a thoroughly practical knowledge of mining should not be accompanied by considerable scientific attainments, and the mining engineer will find it advantageous to have some acquaintance with nearly all the exact and physical sciences.

"It is true that no amount of purely scientific or theoretical knowledge will fit a man to manage even a small mine in the absence of practical experience, but the capability of the practical man is greatly increased by scientific knowledge, and the developments in mining which may occur in the the future, are likely to be in a direction where such knowledge will be more necessary than ever.

"Technical education consists of not only a knowledge of the natural and mechanical forces, but it consists of a knowledge of how to apply them. This knowledge becomes a broad knowledge only when the student keeps posted on the manner or methods employed in applying these forces by other successful men. If he depends on his own apitude only he will work in a comparatively narrow groove.

"I would therefore urge all young men studying mining to endeavor to obtain scientific knowledge as well as practical training. Apart from the material advantage to be derived from scientific knowledge, it trains the intellect, and often develops a taste for some special branch, the study of which, instead of being a task, becomes a source of absorbing interest and unalloyed pleasure."

ACCIDENTS FROM FALLS OF ROOF AND SIDES.

MR. W. N. ATKINSON, in his presidential address to the members of the North of England Institute of Mining Engineers, showed that in Great Britain, as well as in this country, the most frequent cause of accidents in mines was "falls of roof and sides." While it is true that many accidents of this character arise from neglect, and a total disregard of the promptings of the instinct of self preservation, yet it must be admitted that many of our best and most industrious miners are liable to injury or death from this cause. Their anxiety to secure a "good day" inclines them to run risks that place them in jeopardy.

The following table, covering a period of forty-two years in British mines, is of great value in supplying a contrast for gauging the progress being made in reducing the number of accidents due to this cause.

Class of Accidents.	Total No. of Accidents 1851 to 1894.	No. of Deaths from this Cause 1851 to 1894.	Percentage Proportion of Deaths.
Explosions of fire-damp and coal dust,........	2,126	9,706	21
Fall of roof and sides, .	18,226	18,814	40⅛
Shafts,....................	5,565	6,263	13⅛
Miscellaneous, underground,...............	7,199	8,160	17⅛
Surface,....................	3,302	3,484	7½
Totals,...............	36,418	46,427	100

Mr. Atkinson say's, "Falls of roof and sides in mines have always been, and probably always will be, accountable for more accidents and deaths than any other cause. It is a danger common to all mines, and one to which every person engaged underground is to some extent continually exposed."

Any proposal, therefore, that embodies a good scheme for reducing the percentage of this class of accidents cannot but be hailed with unqualified pleasure, and as the president of the Institute noticed a probable plan of accomplishing this very desirable end, we give it here:

"On the other hand, there appears to be a growing feeling that by the adoption of what is called systematic timbering, greater safety would be secured, and my own experience leads me to conclude, that, conjointly with efficient supervision, this is the most likely direction in which to look for further improvement."

BORE-HOLE EXPERIENCES.

IT may almost be said, that we know more about the surface of the sun than we know of the interior of the earth, but with increased knowledge of the physical and exact sciences, and especially with the aid of the new revelations, that the core system of boring is continuously bringing to our notice, we will soon be able to sound the depths of the nether regions. These remarks are prompted by the facts given in *Kuhlow's German Trade Review*, concerning a boring in Germany. It appears a deep boring is in the course of being made at Sondra in Germany with a 7 inch bore tube, and after reaching a depth of 354 feet, by some strong, and unusually active interference, the tubes were disjointed and jammed, and therefore operations had to be for some time suspended until they were recovered. It is further shown that the tubes alone cost $2500 so that the cost of 354 feet of hole, and the cost of the tubes, were jointly an investment that was worthy of recovery, and therefore great efforts were made with strong grapples, to disengage the upper lengths, and so reach the bore end containing the core, and in this they were successful in the face of unparalled difficulties, even greater than those experienced in oil-holes. This brings us to the point that is of interest in this article. At a depth of 354 feet the bore cut into a cleft or open gash in the strata, that was so small, indeed, that it made a gash in the six-inch core, but did not cut it in two, and out of this small cleft a mighty blower of carbonic acid gas rushed into the bore-hole, with a pressure of from 39 to 42 atmospheres, or 588 pounds pressure on the square inch, and the terribly intense cold due to the expansion of this gas and the deluge of water thrown with it, along with a shower of small stones like pebbles, all conspired as allies to defeat the task of the drillers, who were doing their best to extract the broken tubes. This task required heroism to combat with the intensely cold "mineral" water, (or perhaps, as the depth of cold would suggest, the *salt water*), the cannonade of pebbles and the suffocating gas. It appears that the vertical column of water, gas and stones reached an elevation of 46 feet. The query confronting us, however, is this: What was the source of this gas? and as we have no particulars given in the account before us of the topography of the region, we must remain in speculative uncertainty, but let us notice that in all occurences of this character we should know the cause or causes, or be careful to furnish such details or descriptions as might lead us by inference to forecast such a large outburst of gas in future cases, and in knowing the cause to work out a remedy.

ELECTRIC MINE LOCOMOTIVES.

THE General Electric Co. recently supplied the Enterprise Coal Co. with one of their excellent electric mine locomotives for use in the Enterprise colliery near Shamokin, Pa. While this locomotive is the first of its kind in the neighborhood of Shamokin, it is not the first electric mine locomotive used for underground haulage in an anthracite mine with the coal seams on considerable inclination, as is stated in the daily newspapers.

The first electric mine locomotive in practical use in America was put to work in the Lykens colliery of the Lykens Valley Coal Co., near Lykens, Pa., in the summer of 1887. This locomotive was, and is still in use in a water level opening, and the seam of coal cut by this opening has as heavy, if not a heavier pitch than that at Enterprise. This locomotive was illustrated in THE COLLIERY ENGINEER AND METAL MINER for September, 1887. It was designed and built from plans by Mr. Schlesinger, of the Union Electric Co. of Philadelphia, a company that has been out of existence for several years. Besides this original locomotive, a second one built on the lines of the first, and constructed at the colliery has been in operation for several years past, and in a gangway driven in an inclined seam. The credit of being the first mine manager in America to adopt electric mine haulage belongs to Mr. T. M. Williams of Lykens.

There is no reason why the introduction of an electric locomotive in a mine working inclined seams should be remarkable, as such mines, as a rule present even simpler haulage propositions than mines working flat seams. The question of electric haulage in flat seams has long ago been settled in a manner highly favorable to the electric locomotive.

AN IMPORTANT OPINION.

AN opinion that is of great importance to the coal mining industry, is that recently formulated by Deputy Attorney General Elkin of Pennsylvania for State Mine Inspector William Stein of Shenandoah, Pa. This opinion is to the effect that the word miner as used in the phrase "practical experience as a miner," in the anthracite mine act of 1881, includes laborers, loaders roadmen, repairmen and others who work in the mines, but who do not actually mine coal. This opinion will doubtless increase the number of applicants for examination for mine and assistant mine foremen.

EXPLOSION OF GAS.

An Explosion of Gas at Dorrance Colliery, Wilkes-Barre, Pa., Results in the Death of Seven Men, Including an Entire Corps of Surveyors.

An explosion of gas at the Lehigh Valley Coal Company's Dorrance colliery at Wilkes-Barre, Pa., on the 7th ult., resulted in the instant death of three young mining engineers and a fire-boss, and injuries to two others of the engineer corps and a miner, which subsequently caused death.

The mining engineer corps, under the direction of William Jones and consisting of William Cahill, Llewellyn Owen, Robert Blanchard and Robert Miller, entered the mine early in the day to make the regular periodical survey. They were accompanied by Daniel J. Davis, one of the fire-bosses of the colliery, whose duty it was to enter the various openings ahead of the corps and examine them for gas, so as to avoid unnecessary danger.

The corps had about completed its work for the day, and the young men comprising it, with fire-boss Davis, were on their way to the foot of the shaft. Mr. Jones, on examining his blue print of the workings, which he had along for reference, discovered that he had forgotten a little work. Leaving Miller and Blanchard where they were to take care of the instruments, Jones took Cahill, Owens and fire-boss Davis with him to finish the work. About ten minutes after leaving Blanchard and Miller, the party went into some old working, encountered a large body of gas, which was ignited, with the fatal results already noted.

How the accumulation of gas occurred is not definitely known. The mine has always been known as a gaseous one, and every effort was made to keep it free from dangerous accumulations of gas. The opinion of General Superintendent Moister, as expressed at the coroner's inquest, was that the gas accumulated in the old chamber while the fan was stopped for about three hours, the previous day, to enable some repairs to be made on it.

District Superintendent Jones, in his testimony, did not hold to this view, but thought the accumulation of gas might have been due to a local fall of roof blowing out some air stoppings and thus causing the ventilating current to take a short route past the workings in which the gas accumulated. Foreman Thos. Samuels testified as to the method of circulating the air through the mine. He had no theory to express as to what caused the accumulation of gas. He did not know of any stoppings having been blown out by a fall, and was unable to state whether the stoppage of the fan the day previous caused it or not.

Fire-boss John Bloomberg testified to having examined the chamber in which the explosion occurred, the morning previous, before the fan was stopped, and said he found no gas.

The testimony of several miners working in that district of the mine was to the effect that the ventilation was all right, and the usual quantity of air was passing the several points at which they were working.

The evidence also deduced the fact that Inside Foreman Samuel had directed Fire-boss Davis to go ahead of of the engineers and see that every place was safe before they entered.

When Davis's body was found his safety lamp was hanging at his belt, and an ordinary miners' lamp was on his hat. This was presumptive evidence that he fired the gas by using a naked lamp, and the Corner's jury brought in a verdict that the accident was caused by his carelessness. This accident is, therefore, another instance of carelessness causing the death of not only the man responsible for it, but the loss of six other valuable lives.

Morris, the miner among the killed, was 40 years of age. Davis, the fire-boss was 35 years of age, and was well-known in Welsh musical circles, as he was possessed of a fine baritone voice. He was a man of most excellent character and reputation as an official. He undoubtedly thought the workings free of gas, and he paid the penalty for the assumption with his life.

The men comprising the engineer corps were all promising young men of superior intelligence, and excellent character. Jones, the head of the corps, was the only son of aged parents, of whom he was the only support. Owen was the son of W. D. Owen, Division Superintendent of the Lehigh Valley Coal Co's, Pittston and Smithville collieries. Cahill was the son of William J. Cahill, chief mason for the Lehigh Valley Co. Blanchard and Miller whose injuries resulted in death some days after the accident were both promising young men.

MINE INSPECTION IN ILLINOIS.

The Recently Appointed Inspectors, Their Districts and Governor Altgeld's Instruction to Them.

Through the courtesy of Hon. Geo. A. Schilling, Secretary of the Bureau of Labor Statistics of the State of Illinois, we are enabled to publish the following information regarding the future State mine inspection in Illinois.

On the 21st inst. Governor Altgeld re-appointed James Keating, of Peoria; John Keay, of Springfield and Thos. S. Cummings of Gardner, as mine inspectors. He also appointed Charles Duncan, of Streator; Robert Picket, of Spring Valley; Henry Malloy, of Decatur, and James Bennett, of Hallidaysburgh, as new inspectors. Previous to this time the State was divided into five inspection districts. The last legislature increased the number of districts to seven, the two new districts being formed from portions of old ones.

The new districts, with the inspector assigned to each are as follows:

First District.—James Keating, Inspector; consisting of the following counties: Boone, McHenry, Lake, De Kalb, Kane, DuPage, Cook, LaSalle, Kendall, Grundy, Will, Livingston and Kankakee.

Second District.—Charles Duncan, Inspector; Jo-Daviess, Stephenson, Winnebago, Carroll, Whiteside, Ogle, Lee, Rock Island, Henry, Bureau, Mercer, Stark, Putnam, Marshall, Peoria and Woodford.

Third District.—Robert Pickett, Inspector; Henderson, Warren, Knox, Hancock, McDonough, Schuyler, Fulton, Adams and Brown.

Fourth District.—Henry Malloy, Inspector; Tazewell, McLean, Ford, Iroquois, Vermillion, Champaign, Piatt, DeWitt, Macon, Logan, Menard, Mason, and Cass.

Fifth District.—John Keay, Inspector; Pike, Scott, Morgan, Sangamon, Christian, Shelby, Moultrie, Douglass, Coles, Cumberland, Clark, Edgar, Montgomery, Macoupin, Greene, Jersey, and Calhoun.

Sixth District.—Thomas S. Cummings, Inspector; Monroe, St. Clair, Madison, Bond, Clinton, Fayette, Marion, Effingham, Clay, Jasper, Richland, Crawford, and Lawrence.

Seventh District.—James Bennett, Inspector; Washington, Jefferson, Wayne, Edwards, Wabash, White, Hamilton, Franklin, Perry, Randolph, Jackson, Williamson, Saline, Gallatin, Hardin, Pope, Johnson, Massac, Union, Alexander and Pulaski.

The old Inspectors failing of re-appointment were Hugh J. Hughes, of Litchfield; and Edward Fellows, of Galva. The inspectors are appointed for two years at a salary of $1,800 per annum.

On Wednesday, October 23, 1895, the seven inspectors appeared at the Executive Chamber by appointment, and Governor Altgeld took occasion to give them a general talk respecting their duties, and the policy of his administration regarding the mine inspection service.

The governor said:

"The mining laws of this State were enacted for the protection of the weak and poor. The operator, who is strong, can take care of himself. These coal miners are sometimes ignorant of their rights; always poor and dependent, and cannot manifest their dissatisfaction with objectionable conditions prevailing around the mines without risking their jobs. You are therefore appointed by the State to do for them what they cannot do for themselves. I therefore insist that in inspecting mines, you do so without permitting the operators or their representatives to accompany you.

"Make your inspection thorough and independent, without their aid. After you have done so, find out from the men if there is any ground for complaint among them. The relation of the inspectors and coal miners of the State should be of the most confidential and cordial character. No miner should hesitate to speak to you about the condition of the mine, for fear that he might be reported. While I insist upon a rigid and thorough enforcement of the law, for the health and safety of the miners, I expect at the same that you will be respectful and courteous to the operators.

"I further wish to say that there have been entirely too many accidents; not that there have been more within the last few years than formerly, but I mean to say that there were some accidents that should have been avoided. I know that accidents will occur, in spite of all that you can do, but I desire that, in the prosecution of your work the coming year, you will be so vigilant in the discharge of your duty, that no accident will occur which can by proper attention be avoided. Should there be any such accident the inspector in whose district it occurs will be in peril of losing his job."

The governor here entered into a lengthy explanation of the causes of the accident at Petersburg where several men were crippled, and said that while the inspector may have had no knowledge that the company was dropping their cage with greater speed than the law allows, still had he sounded the men during the inspection, he might have secured from them the information that the company was transgressing the law. Furthermore, when an accident occurs, he forbade them from going to the injured man's home with the company's representative insisting that the miners would not, and could not speak in their presence with the same freedom, respecting the cause of the accident, that they would with the inspector alone.

He also cautioned them from becoming agents of mining tool companies, because it would lead to more or less dependent relations with the coal companies, and would destroy to that extent their efficiency in the service of the State.

The conversation then turned upon the practicability of enforcing the enactment of the Thirty-ninth general assembly, making the mine inspectors ex-officio inspectors, of weights and measures, that is to test scales at coal mines. It is believed by the inspectors, and the belief is shared by Secretary Schilling, that the enforcement of the law is problematical, because of the expense it will entail it carrying the weights from place to place. The inspectors thought that no less than 1,000 pound weights would be adequate. The law insists upon one inspection every six months. The express companies would charge $4 for shipping 1,000 pound weights fifty miles or less. Additional cost for hauling from station to mine, including helper, and again from mine to station, would cost an additional $4. This would make for the 850 shipping mines throughout the State something like $27,000 for the two years, for which the Thirty-ninth general assembly did not provide one cent.

The inspectors and governor, however, will consider ways and means by which the law may be enforced at a nominal expense, meanwhile the subject is *in statu quo*. In taking his departure, the governor again reminded the inspectors that he wanted them to discharge their duties with more vigilance and energy than had ever been done before, and that he would be satisfied with nothing less.

Mine Equipment Makers.

With this issue of THE COLLIERY ENGINEER AND METAL MINER, the Mineral Ridge Mfg. Co. of Mineral Ridge, O., begin a series of advertisements calling attention to the line of mine equipment they are now prepared to build. Mine cars are a specialty, but they are prepared to undertake anything from a car wheel to a steel tipple. Screens and coke larries also occupy a prominent place in their catalogue.

A miners' pick is as important in its way as a hoisting engine, and with this issue the Fulton Tool Works of Canal Fulton, O., begin an advertisement of the mining tools and supplies made by them. They are prepared to furnish anything in mining tools needed either in the anthracite or bituminous mines.

Users of wire rope will hereafter find among our advertisers of such, the card of the Williamsport Wire Rope Co., Williamsport, Pa., and will, we trust, not overlook the new patrons of THE COLLIERY ENGINEER AND METAL MINER, when in need of rope for hoisting or haulage use.

A Handsome Publication.

The Repauno Chemical Co. of Wilmington, Del., the largest manufacturers of high explosives in America, have just issued a beautiful pamphlet of eighty pages profusely illustrated by half-tone engravings and all printed on heavy plate paper. The book is an exceedingly interesting one, and will be appreciated by every mine manager who receives a copy of it. It will pay to send for a copy, which will be sent free on request to the Repauno Chemical Co., Wilmington, Del.

PERSONALS

Mr. Chas. S. Herzig, E. M., whose interesting descriptions of the Tamarack and Osceola copper mines were published in this journal a few months ago, has accepted a position with the Anaconda Mining Co. at Anaconda, Mont.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

Steel Girders for Mines.—In September, this year Mr. E. Thompson read a paper on the "Use of steel girders in mines," before a meeting of the Federated Institute of Mining Engineers, and here is the important portion of the paper:

"An instance of the advantageous substitution of steel for timber is found in the present extensive use of steel girders in engineering structure where timber beams were formerly employed. Although the conditions of the use of girders in mines differ very considerably from their use in building construction, yet the various properties of steel, its strength and durability, enable a girder to show equally satisfactory comparative results when used there for supporting the roof, as when used for any other purpose. As an instance of the difference in the working conditions to be met with in a mine, it may be mentioned that the weight to be supported in some places is not only unknown, but practically irresistible, and the strain is further complicated by pressures both from the top and the sides. Instead of being regular and uniform, the load is varied, and in cases increases with sudden and tremendous force. In addition to these strains, earth movements occur, which tend to displace the supports of the beam, and tend to allow the framework to collapse. Heavy falls of roof also occur on the breaking of the beam, involving heavy costs in clearing away, and by the inconvenience of the delay caused by the obstruction. In such cases the strength, durability and ductility of a steel girder, as compared with a timber, are seen to great advantage. They carry heavier loads, the safe dead load of an iron girder being one-fourth of its breaking load, to one-fifth of the breaking load in the case of timber. Steel girders seldom break under sudden weights, and by bending give indications of pressure and an opportunity of relieving it. As a proof of their ductility a Bessemer steel girder, 5 in. in depth by 4 in. in breadth of flange, weighing 22 lb. per foot, with the weight applied at the center, took a permanent set of 1½ in., under a load of 14 tons, and showed a deflection of 7 in. under a load of 17 tons without breaking, and instances of greater deflections have occurred in practice. It may be mentioned that in the mine where girders were placed here and there amongst timber bars, the latter have been broken while the girders remained u-injured. If not too much bent, girders can be reset, crown upwards, or can be straightened for resetting, at a moderate cost, and are but slightly impaired by the process. These severe conditions do not exist everywhere; there are many roads in mines where the weight may be taken as fairly uniform, an approximate estimate formed as to the strength of the beam required, and a suitable girder can be selected, so as to obtain the best results. The sections of girders in general use in main roads are as follows:

Depth of girder.	Width of flange.	Thickness of web.	Weight per foot.	Estimated safe dead distributed load for an 8ft. span
In.	In.	In.	Lb.	Tons.
5	4	[illegible]	16½	7
5	4	[illegible]	22	9
6	4½	[illegible]	24	12

"The safe loads are calculated at one-third of the breaking weight of the girders. On account of the varying conditions of mines it is impossible to give a table of fixed minimum and maximum length at which the various sections may be safely used. In some instances a 9 ft. girder (for an 8 ft. span), of the highest section, is used in the place of larch timber 9 in. in diameter. In others (taking the same span) a section weighing 22 lb. per foot is required in the place of larch 10 in. in diameter. The heaviest section in other cases has to be used as a substitute for heavier timber. Under comparatively equal loads the various sections of girders may be used as follows:—

Weight per foot.	Length of bars.
Lb.	Ft. Ft.
16½	6 to 8
22	8 to 10
24	10 to 14

"Where weights come on suddenly and with great force it is safer to use the heaviest section, and in exceptionally heavy parts of a road the girders may be spaced more closely together. In wider spaces, where a central support can be used, the strength of a girder is doubled by adopting their use. The relative costs are easily ascertained at any time, being dependent upon the fluctuations of the steel and timber markets. At the present time, estimating the girders at £5 per ton, these sections cost respectively 9d., 1s., and 1s. 1d. per foot. Comparing these prices with best larch timber, the cost of girders is very little in excess of timber, and if the cost of cutting and trimming the timber be included, with an allowance for waste, steel girders will probably be found to cost less per foot, and in addition prove much stronger. Steel girders are also more easily handled, and cost less to set in position. A larch bar 9 in. in diameter and 9 ft. long contains 5 cubic feet, and weighs when dry, 19 lbs. per foot. A larch bar 10 in. in diameter and 9 ft. long, contains 6¼ cubic feet, and weighs 24½ lbs. per foot. At 1s. 3d. per cubic foot these bars cost respectively 6s. 3d. and 7s. 9½d. each, while a 9 ft. steel girder of light section costs 6s. 9d., and of medium section costs 9s. A larch bar, 10 in. square and 8 ft. span, is calculated to break under a load, placed at its centre, of 17 tons. Girders compare favorably with timber, as they give an additional 4 or 5 in. in the height of the road; they possess greater durability where exposed to moist air, which, in some mines, destroys the timber in a few weeks; and they are equally suited for pit bottoms, main roads and return airways. Girders intended for use in very wet places may be tarred at a slight cost. They can be drawn and reset many times, where perhaps timber would not be worth the cost of recovery. In the event of fire, timber is not only destroyed, but helps to spread its effects, while girders remain intact, and the road in good order. The blocking of the roads caused by floating timber is also avoided should the mine be flooded with water. The methods adopted in the setting of steel girders are similar to those employed in setting timber bars. The most general modes are to insert the ends of the girder into holes cut in the sides of road, or to support them on walls or wood props. When side pressure has to be met, girders resting on wood props must be wedged at the joint, to prevent the props from being displaced. Another method is to form a shoulder on the girder to form a support for the head of the prop. It is very important to keep the girders upright; where allowed to cant over their utility is considerably lessened. A ready method for maintaining them upright is to place light timber horizontally from girder to girder, the ends of the timber being held between the flanges of the girders. When canting over they tend to split the wood props upon which they rest, owing to the edge of the flange of the girder being forced into the timber. To meet these cases a shoe, made of iron or steel, may be placed upon the under flange of the girder. Its under side forms a cap, and fits on the top of the wood prop. This shoe answers the triple purpose of preventing the canting of girders, the splitting of the wood props, and their being displaced by lateral pressure, or by collision with tubs. Girders are also used as props to supports the girder bars, the light section being equal in strength to the timber generally used for that purpose. To secur the girder props, and so form steel settings, various appliances have been introduced, so that in constructing the settings there is no need for cutting or punching of the girders, which would tend to weaken them. The first of these appliances is an iron or steel clip, made in two pieces, one-half of which fits on either side of the bar and prop when set in the required position, and a bolt passed through the clip securely holds the framework against distortion by any pressure. The ends of the girder being firmly held, it is able to carry nearly double the weight carried by a girder whose ends are loose. Another appliance is a wrought iron holdfast or band, made in one piece, and placed obliquely over both the girder and prop when set. An iron bolt is passed through the holdfast at the point where the girder rests on the prop, and forms a shoulder to prevent its displacement. As the holdfast passes over the top of the girder it has a greater leverage and extra proportionate power in preventing the canting of the girder. A third appliance is an iron or steel chair, in which the end of the girder and the top of the prop are placed, and are held securely against any movement. Steel settings are also constructed, in the formof arches, circles, rectangles, or squares, and are capable of resisting enormous pressure, and prove an efficient substitute for brick-arching."

Recovery of the Karwin Colliery.—The following important particulars of the recovery of the Karwin colliery in Germany, that was lost by a fire resulting from an explosion on June 14, 1894, are taken from the Colliery Guardian. "The commission appointed to organize the works necessary for the recovery of this colliery after the explosion of June 14, 1894, had several more or less conflicting circumstances to consider in deciding on the means to be adopted. In the first place it was desirable, both from the owners' and the miners' point of view, to reopen the pits as soon as possible. On the other hand lay the risk of the fire not having been extinguished, and the consequent danger of its extension on the readmission of air—a danger militating against the adoption of the most rapid method—viz., direct ventilation. Against the proposal to put out the fire by flooding the mine was the serious objection that with the natural supplies of water available this would take about twenty months to accomplish, seeing that some 870,000 cubic metres of water would be needed to fill the pit, not to mention that the pumping out again of this amount of water, coupled with that of the average daily influx, would occupy a further space of 320 days with the pumps at hand kept constantly at work. Besides, the region of the fire would naturally be the last portion of the mine to be reached by the water, and the first uncovered by its removal, so that inundation would not constitute any positive guarantee against renewed outbreak. After reviewing all these points it was decided to proceed by first ventilating the Tiefbau (pumping) shaft as being farthest away from and least affected by the explosion.

"All the shafts had been closed after the accident, and frequent samples of the air in the mine taken for analysis. It being found that up to the end of June the percentage of CO was barely noticeable, it was assumed that the fire at any rate was making no headway, and that careful ventilation of the Tiefbau shaft might safely be attempted. Accordingly, on July 2, the pumps having been set going a week earlier in order to clear the flooded V. horizontal, this shaft was opened and the fan set to work. Shortly before mid-day a party descended and visited the II., III., IV. and V. horizontals as far as the sixteenth seam. The erection of stoppings to shut off this portion of the pit from the seat of the fire was commenced, but the explorers had to retire at about 3 p. m. on account of the increase of CO in the atmosphere. On the following day the erection of stoppings was continued, but a rise in the percentage of CO (up to 0.5) again forced the workers (seventy-five men) to withdraw at about 10 p. m. Owing to a breakage in the pumps the work in this shaft could not be resumed until the 11th of July, but in the interim the cover of the Franziska shaft was removed to allow the escape of the high-pressure fire-damp, although nothing further in the way of ventilation was practicable for fear of feeding the fire. The difference of density between the fire-damp in this shaft and the outside air caused a current to set in towards the fire, and it was with difficulty that this could be arrested by stoppings, since the interruption of the southward draught caused an influx of fire-damp from the east, filling up the seventeenth seam. However, the erection of these stoppings isolated the Tiefbau shaft, and rendered its thorough ventilation possible, and the next proceeding was the isolation of the Wilhelm seam at the IV. horizontal, a necessary preliminary to the recovery of the Franziska shaft. The air being free from CO, the men where able without danger to fix a brattice against the crossway in the nineteenth, seam, and cut this off from the Franziska.

"By September 25 the ventilating apparatus in the Franziska shaft was completed. The shaft was then explored down to the water level, and the stoppings examined and made good. As behind the sluices a depression of about 30 mm. prevailed, it was found necessary to erect partitions a few yards from the troughs, shuttered in order that the varying amount of depression could be counteracted in the intermediate space. Similar means were adopted in the eastern section of the pit to overcome the compression of the afterdamp from the seat of the fire.

"A good deal of water from the direction of the Tiefbau shaft was dammed up by the *debris*, and the simultaneous removal of both was attended with difficulty. To prevent air entering through the watercourses, sliding shutters were fixed at the base of the dam doors, by which means the channels could be completely closed.

"The men worked in three-hour shifts in the respirators, and for a further three hours as watchers at the partitions, attending to the respirator tubing, &c.

"A quantity of water found dammed up at the IV. horizontal was run off on October 1, its removal being followed by a remarkable change in the composition of the air in the Tiefbau shaft, where the amount of CO_2 rose suddenly from 3.6 to 8.5, the oxygen decreasing from 12.2 to 0.6, with an alteration of pressure from — 22 to + 10. This gave rise to considerable uneasiness, as being possibly caused by a sudden extension of the fire, but it was afterwards ascertained to be due to the sinking of the heavy afterdamp into the workings previously filled by the water in the Wilhelm seam.

"The results obtained from the observation of the variations in the composition of the gas in the mine may be summarized in the statement that diminution of atmospheric pressure induces an increase of CO_2, and a decrease in the amount of oxygen, the internal depressions tending to disappear and the compressions to rise; in other words, the proportion of oxygen increases with depression and that of CO_2 with compression.

During the months of September and October work was continued by the erection of stone stoppings in III. and IV. horizontals and the removal of *debris*. The building of an explosion-proof stopping of cemented masonry, 43 in. thick, and with a rounded face on the danger side completed the isolation of the III. horizontal. The compression test having revealed a connection with the fire region *via* the II. horizontal, stoppings were begun at that level, the recovered part being ventilated by means of horizontal troughs, 30 cm. in diameter, branching from the vertical main.

"After erecting an explosion-proof dam in the II. horizontal, rather thicker than the one on the next level, the exhauster and troughs were removed from the Franziska shaft, the large cage replaced, stoppings made good, and the clearing up of the recovered workings proceeded with. Coal-getting was resumed in both shafts about Christmas, and the sphere of action in recovery work transferred to the Carl shaft, where the same procedure was adopted as in the western section. As soon as the stoppings were erected the compression of gas from the burning portion of the pit rose to such an extent that it was deemed advisable to bore through the safety dams and convey the gas through iron pipes up to the bank.

"The percentage of methane in the horizontal workings amounted to between 40 and 60 per cent., and was, therefore, beyond the limits of explosibility. Nevertheless, for the first few yards beyond the partitions, owing to the admission of air every time these were opened for the men to pass through, the proportions of air and gas were such as might readily explode should a spark be produced or one of the electric lamps be broken; in fact, in the Carl shaft such an explosion did result from the breaking of a lamp by a stroke of the pick, and eleven men were injured. The lamps were therefore strengthened by extra glass, and a covering of wire gauze. As regards efficiency the English Bristol lamps were much more satisfactory than those obtained from Vienna, burning six hours, whilst the latter only lasted for two or three hours without recharging.

"So far the burning field has been isolated from both sides, and subsequent operations will be directed towards still further encroachments on its area, but this difficult and dangerous work will be of necessity slow, and the damage wrought in a moment by the explosion of 14th June will take years to repair."

The Rock-Phosphate Deposits of Florida.—Two papers treating on the phosphate deposits of Florida, were read by Messrs. G. M. Wells, of Ocala Florida and E. T. Cox, of Albion Florida at the March meeting, 1895, of the American Institute of Mining Engineers. The time is near at hand when nations and people will jealously safe-guard their phosphate deposits as treasures that cannot be exchanged for gold. The elements carbon, hydrogen, oxygen, nitrogen and lime are indispensable in the building up of organic compounds, but the selective principle of life that gives activity to the organs of an organism in the discharge of their functions is phosphorus.

This element is possessed of great vitalizing power, and when used to recuperate the soil, it replaces sterility with fertility, and as human poverty and despair and wealth and satisfaction, are coeval with, in the first case an exhausted soil, and in the second with a productive soil, we can see that the phosphates are of inestimable value to man.

The most abundant supplies of phosphate of lime or phosphoric acid are derived from animal remains, in one of two forms, first, as recent surface deposits that are found along the coasts of continents, or are found to cover the surfaces of lonely islands in the sea. As the coast of Peru on the shores of the Pacific ocean, and the coast of some of the main lands in the Antarctic seas, where live and die in countless millions those singular birds the wingless penguin. The other source of the phosphate is a mineralized deposit of the petrified dung of fish lizzards, that swarmed in the seas of the Tertiary period and this mineralized form is recognized by different names, such as coprolites, and hard rock phosphate as Mr. Wells calls it and boulder and gravel phosphate as Mr. Cox calls it.

Now we arrive at the consideration of that phase of the subject treated on by the papers under notice. First then the Peninsula State of Florida has a surface area on the Pliocene rocks, of great extent. The outcropping rocks at the southern end of the State, between the 25th and 28th parallels of latitude, and stretching from the eastern to the western shores of the State, are all of the Pliocene period, and the surface rocks near to, and along the north-western shores of the State are all of the Miocene period, and it is in the latter, that the phosphates are found and mined, and this is made very clear by a well drawn map of the State that is introduced for illustrating Mr. Wells' paper.

The phosphates are found in pockety clusters, within a belt of rocks of nearly uniform width and the string of pockets from the Apalachicola river on the western side and northern end of the State to the Caloosahatchee river on the western side and the southern end of the State. The belt of pockets is therefore about 250 miles long and 15 miles broad and runs nearly parallel to the major axis of the State.

A good idea of the course of this zone of phosphate can be obtained from Mr. Wells' paper in which he says: "Each of the groups is made up of a series of small deposits, many of which have a surface area of only one-eighth of an acre, while some have an area of three quarters and others an area of four acres.

"A few of the patches are larger than those noticed, but when this is the case, the productive rock does not reach so great a depth as in the case of the smaller pockets; and further, in these deposits of large surface area the stone is of a lower grade and so interstratified with the limestone strata that easy and profitable mining cannot be pursued." At the southern end of the State, overlying the Pliocene rocks, drift deposits of pebbles broken from the phosphate rocks are found.

Mr. Cox says: "In this district, Albion, the phosphate is designated as 'hard rock' or 'boulder phosphate,' or gravel phosphate. The boulders range from lumps as large as a man's head, up to 50 tons in weight.

"When cleaned it yields on analysis from 75 to 85 per cent. of tricalcium phosphate of lime, and from 2.5 to 3 per cent. of phosphate of iron."

The phosphate miners of Florida have furnished another proof of the fact, that mining to be scientifically and commercially successful, requires courage, and the true genius of mechanical resource. For the risk of capital can only be reduced to a minimum by the adroitness of the mining engineer that can originate new appliances to make the transaction pay by the adoption of processes adapted to the conditions under which the mineral is found.

Mining by water as a solvent has been very successful in obtaining salt and sulphate of copper, but mining by dredging is certainly something new. It appears that a great inflow of water takes place below depths of from 10 to 20 feet in the phosphate, and pumping was at first tried to drain the mines but the volume of inflow was so great, that the cost of drainage cast the balance on the wrong side of the accounts, and then dredging or scooping was tried with the result, tt at we will let Mr. Cox narrate:

"Mr. W. N. Camp of the Camp Phosphate Company, concluded that he would try mining with a steam dredge. Accordingly, he had a dredge boat made and launched into the pool of water. Contrary to all predictions of failure, it proved to be a grand success, and solved the problem of hydraulic mining with a dredge. The importance of mining with a steam scoop-dredge can be understood when it is shown, that two-thirds of the mineral lies below the water level, and that the scoops can do the mining cheaper than the hand-pick and shovel, for mining by hand costs from \$2.50 to \$3.00 a ton, whereas, mining with Mr. Camp's steam scoop dredge rarely costs more than \$1.00 a ton. Surely this is a grand reward for the new departure in which the water that submerges the mineral, is made to assist the steam scoops in mining it."

West Virginia Mine Inspectors Reports.—The Reports of the Mine Inspectors of West Virginia are to hand for the year 1893 and ending in June 1894. The reports for the first district shows that the output of coal for the year was 2,714,818 tons of 2240 pounds to the ton, and the output of coke was 208,146 tons of 2000 pounds to the ton. These figures show a falling off in the production, as the result of a strike. The total number of employes engaged in the coal and coke production was 4,716. The total number of non-fatal accidents was 33 and the majority of these were due to falls of coal and slate. There were 13 fatal accidents from different causes, but chiefly from the same prevailing cause as in the non-fatal accidents. There are 44 mines in the first district, 22 have natural ventilation, 1 steam jet ventilation, 6 furnace ventilation, and 15 are ventilated with fans, so that the fan maker has a nearly virgin district for his productions. The tables of the analyses of coal and coke show that the West Virginia fossil fuels, or "black diamonds" are of grand merchantable quality, for the average of the coal ash is 5 per cent, and that of the coke is 9.5 per cent.

The report of the second district shows that the output of coal for the year under notice, was 10,928,820 tons, at 2240 pounds to the ton, or a slight decrease from that of the previous year. The output of coke was 1,090,809 tons at 2000 pounds to the ton, or a large decrease on that of the previous year.

The number of employes engaged in coal and coke production is not given. The number of non-fatal accidents is given as 6, and the two causes, were falls of coal and slate, and falling between the cars. There were seven fatal accidents, and all but one, were caused by "falls of slate." There are 32 collieries in this division, and only 6 of them are ventilated with fans, 7 have natural ventilation, and 19 are ventilated with the furnace. By the tables of analysis the percentage of ash in the coke, is 9.7, and the average ash in the coal is under 3 per cent.; now this cannot be right, for supposing the coke produced be 65 per cent. of the coal poured into the ovens, then the percentage of ash should be 6.3.

Report of the mine inspector for the third district shows that the output of coal for the year under notice was 5,476,857 tons at 2,240 pounds to the ton, a slight decrease on the previous year, and the production of coke was 858,556 tons of 2,000 pounds each, a slight increase on the previous year. Total number of employes engaged in the production of coal and coke 11,730. There are 98 collieries in this district and 9 of them are ventilated by natural means, 36 are ventilated with fans, and 49 are ventilated with the furnace, one is ventilated with the fire-basket or fire-cage. There were 39 fatal accidents and the prevailing cause was falls of coal and slate. There were 90 non-fatal accidents and the chief cause was falls of coal and slate. Altogether the West Virginia reports are capable of much improvement.

Modern Coal-Tipplers.—In the Transactions of the Federated Institution of Mining Engineers, England, 1895, is a paper on the above subject by Mr. J. J. Prest, and he introduces the subject as follows. "The many different designs of coal-tipplers are evidence of the great advances made during the past ten years in the efficiency and improvement of colliery-plant, and particularly in the appliances adopted for screening and cleaning coal. Formerly a long array of fixed bar screens, each fitted with its own tippler, was seen at all coal-drawing shafts, but now the entire output of a large colliery is concentrated at one point, and passed through a single power-driven tippler at considerably less cost, and with greater efficiency then was the case under the old order of things." He next notices the principles of construction and mode of action of 9 varieties of the power-driven tipplers.

These decanting or emptying devices are a *necessary* adjunct to the "jigger screens" and "sorting belts" used for sizing and dressing the bituminous coals at the mines in England, for here the jigging or oscillating screens are worked by steam power, and therefore rapidly carry forward the coals onto the "cleaning belts," and to keep the screens and belts going, it is neccessary that a copious supply of coals should be constantly pouring onto the jigging screens, and for this to be done with sufficient despatch the tippler must be so constructed as to quickly overturn and empty the cars of coal as they arrive, and for doing this, power must be used, and this is supplied by the engine that oscillates the jigging screens and turns the belts. There are three distinct types of the power-driven tipplers, first the rotary tipplers, or those in which the plane in which the tippler turns is parallel to the plane of the car wheels, and generally considered, the mode of action is as follows, the the cars gravitate from the mouth of the hoisting shaft down a gentle pitch into a frame, that revolves the moment a clutch is made to seize by being actuated with a hand lever, the frame now turns once round, and empties the car and then discharges it, when it moves over a horned belt, one of the horns of which catch the hinder axle, and carry the car up an ascent, where it is disengaged and continues its journey by gravitation down to the mouth of the shaft again. Of this class of tippler Mr. Prest gives Wood and Burnett two varieties, Silvester, Shelton, and the Heenan and Fronde.

The second type is the end tipplers as the Heath and Woodworth, and the third type or side tipplers, are the Blackett, the Pelsall, and the Tate.

The Cornwall Ore Hills.—Mr. J Birkinbine in the Iron Age says: "The Cornwall ore hills in Lebanon county, Pennsylvania, have a history stretching back over one hundred and fifty years. The earliest mining of the ore was restricted within the limits of the small local demand of neighboring iron works, to which the ore was carried by wagon haulage. The ore was owned by several individuals, each of which had contracted for the entire supply of certain of the small smelters and therefore, the names of the old mines or excavations are really the specific names of the furnaces then in use in the district. The early mining, or open digging in these hills was confined to such outcrops as furnished loose ore ready for loading into wagons, and in this way advantage was taken of large accumulations of "nigger heads," for this class of ore was of superior grade, because it had been for a vast period exposed to the leaching influence of the weather. Among other varieties in iron ore found exposed in these hills, are fine examples of loadstone or magnetic ore. These early miners and smelters fully understood the purifying influence of the weather, for they used to leave extensive faces of the ore in their open excavations exposed for long periods of time.

The march of progress in iron manufacture, as in other branches of art, has made what was once a doubtful variety of ore, one now of first-rate quality.

The ore contains very little phosphorus, but some copper and a rather high percentage of sulphur, the result was in the early days the copper rendered the iron red short, and it was therefore unsuited for foundry castings. Now, however, the same ore is of great value in the manufacture of Bessemer steel on account of the small percentage of phosphorus it contains, and the oxidation of the copper and its consequent elimination as the result of the high temperature at which this class of steel is made. During the last ten years the output of ore from the Cornwall hills has been 6,192,852 tons and of course this large quantity of ore could not have been mined but for the aid of railway transport. The deposit is so vast that it will be long, very long, before the period of exhaustion arrives.

Sampling.—A paper by T. Clarkson, C. E., on sampling, was read before the members of the Federated Institution of Mining Engineers, England, early this year, and as its contents are of some importance, let us here notice the points in it of special importance. First then he shows that the promiscuous or partial sampling of a heap of ore, a heap of coal, or lot of cement cannot do other than mislead the experimenter or tester, and here are some of his claims.

"One of the details which concerns mining engineers, and which has not hitherto received the attention it merits, is the important operation of sampling. This work is frequently done in a most perfunctory and slipshod manner, although so much that is of value depends upon the result. Surely sampling is co-equal in importance with chemical analysis, being in fact, the first practical step in that analytical operation."

Mr. Clarkson after showing why sampling should be accurately done stongly advocates the mixing and sampling of the mass by machinery, and here are the views he thus sustains. "Generally the only way to correctly sample a large bulk of material is to deal with the whole heap, and not as at present with only a small percentage of it." To deal with the bulk is not practicable by hand labor, therefore it is necessary to employ machinery.

"The employment of machinery for sampling has the great advantage of the work being done impartially, the results are obtained more quickly, and, most important of all, the utmost possible accuracy is secured." Referring to an English machine he says:

"Several kinds of sampling machines are in use in America, but the one shown in the model exhibited is, the writer believes, the only one in use in England."

An Outburst of Gas.—The following paper appears in the Transactions, 1895, of the Federated Institution of Mining Engineers, England, and is by Mr. W. Washington on an outburst of gas at the Mitchell Main Colliery of which he has charge. It appears the mode of working is longwall, and the line of the face or working line, is given as half "end on" and "half board," or nearly *short-horn*. The "pack-walls" or gate road-packs are 9 feet wide on each side of each gateway, and the gateways are 66 feet, or 22 yards apart, and at the time of the outburst of the gas from 18,000 to 20,000 cubic feet of air per minute were passing through the district so that the gas could not be a gradual collection and must therefore have been suddenly disengaged.

It appears the gas burst out from the floor of the seam, and this indicates either a workable seam of coal heavily charged with gas under the present workings or else the existence of "coal-pipes," or thin layers of of gaseous coal in the underlying shales. The gas must also have been pent up at a very high pressure, for says Mr. Washington: "The greater portion of the gas appeared to come from the floor, and for a distance of 150 or 200 feet along the face, the floor was considerably lifted, the roof also subsided and the height of it reduced from 5 feet 6 inches to 3 feet. The deputy overman said that the concussion appeared to shake the 'separation doors' at a distance of 840 feet from the point of the outburst."

Iron Ore in California.—Mr. J. J. Crawford in the report of the State Mineralogist, of California, describes the extensive deposits of iron ore which are found in many of the counties of California and if a supply of suitable fuel was at hand, they would no doubt be utilized. Some years ago an extensive plant was errected in Placer County for smelting the ore with charcoal, but the buildings and plant were distroyed by fire and were not restored, the result is iron manufacture has almost ceased in the region. A few hundred tons of iron ore, however, from Shasta county were used by local rolling mills and foundries in 1893, but this was the limit of the production. For a number of years California has been the only seat of the production of chrome iron ore in the United States, and its occurrence has been observed in several counties, but the chief centers of its yield are now the counties Alameda, Glam, San Luis Obispo, Shasta and Tehama. The ore industry in so far as mining is concerned is not very extensive, owing to the facility with which the ore can be imported from Asia Minor. The California output represents only about one-fourth of the total consumption at Baltimore and Philadelphia and cost of transit to these cities is the main reason that the excludes the Californian product.

Iron Ore Mining.—Mr. J. Main in the Iron Trade Review says: Hematite iron ore occurs in the carboniferous limestone in the Whitehaven district in England. The deposit is peculiar in its occurence as it is sometimes found in vertical gashes in the limestone, at other times in pockets, and frequently it is found in what appear to be horizontal beds.

The veinlike masses occur in the partings of faults, and shafts are therefore often sunk on the upthrow sides of the faults and levels are driven 120 to 180 feet apart to intersect the ore. Workings are then commenced right and left, and raises are put up on the foot wall, leaving pillars 60 to 70 feet long. Levels are driven horizontally every 15 to 30 feet from the raises, and when the ground has thus been opened up the pillars are robbed, those farthest from the shaft being worked first.

Debris is used for packing, as far as possible, assisted by timbering. The bed-like deposits occur most frequently in what are known as the first, second, third and seventh limestones and they are worked by the pillar and stall method with the winding shaft sunk to the point of the greatest depression in the lowest bed. The pillars range from 430 to 1620 square feet in area, the size varying according to the local character of the deposit.

When the ground has been opened up, the pillars are taken out, and when the bed is thick the ore is taken out in two layers or benches.

Nickel Ore Deposits.—The following facts are collected from a paper read by Mr. J. F. Kemp before the American Institute of Mining Engineers. Nickel ore is interesting because it has not hitherto been found in great abundance in the United States, and yet it is extensively used in the coinage of the Republic. The principal deposits of this ore found anywhere in the whole of the States, are in the region of Gap Mine, Lancaster County, Pennsylvania, and at Anthony's Nose on the Hudson. The Gap Mine ore is found in a lenticular mass, the greatest length of it being 1,500 feet from east to west, and the width from north to south, 500 feet; it is true there are other regions in the States where the ore of nickel yields a relatively small percentage of the metal but this ore cannot be made to pay in consequence of the reduced price. The metal sold in 1874, for $2.60 per pound, and the selling price now is 75c. The metal is of great value in the manufacture of German silver when it is alloyed with zinc and copper. It is now extensively used for electro plating other metal, and it is therefore interesting to know that 400,000 pounds were used in the United States alone, in 1884, and in 1883, no less than 703,426 troy ounces were used in the coinage of the Republic. The ore called copper-nickel, derives its name from the copper color of the ore, and it contains from 39 to 48 per cent. of nickel and from 46 to 54 per cent. of arsenic. Some of the poorer varieties of nickel ore however, yield as little as one-1 per cent. of the metal.

Iron Ore Mining on the Mesabi Range.—Mr. H. V. Winchell in The Iron Trade Review gives the output of iron ore from the Mesabi Range as 684,194 tons in 1893 and 1,781,574 tons in 1894, when probably not more than 40 per cent. was strictly Bessemer ore although the iron contents probably exceeded 62 per cent. Three quarters of the deposit was obtained by stripping and the mining cost was undoubtedy less than the maximum figure of 42c. given in 1892. After stripping, the ore is either loaded by steam shovels direct into the railway cars, or it is sent down winzes into trams, that are run to the shaft and hoisted to the surface. The cost of working by stripping and filling with the steam shovel is given for the present time at 15c. per ton.

Great variations are found in the character and quality of the ore and some of the mines producing true Bessemer are restricting their output. The non-Bessemer is generally found in the upper bench of the bed of the Mesabi and Iron Mountains, but the entire body of the ore is subject to continual change of character. There are at least two hundred million tons of this ore in the Mesabi district but probably not more than 40 per cent. of this ore is Bessemer and the disposal of the remainder may be a matter of future difficulty.

One of the largest steam shovel mines shipped in about six months 505,000 tons of the ore with a normal force of 85 men on an average of 40 tons of ore per man. The tendency, however, of this large output per man is to produce lower grade ore owing to the mixing of all sorts. Several systems of mining have been tried, but it will probably be found best to work the ore in benches to secure a better selection.

Spathite in Tennessee.—Mr. C. Wilson in the proceedings of the Alabama Industrial and Scientific Society, describes a six-foot bed of spathite, or spathic iron-ore which is found at Iron City, Tennessee, between beds of limestone. It looks like hematite or red ore, and the iron is present in it as ferric oxide, but the percentage of metallic iron in the ore is only about from 21 to 22, and taking this along with its specific gravity which is 2.78 and its percentage of phosphorus .5 and sulphur a mere trace, it is singular that the thickness of the seam, the specific gravity of the ore, and its percentage of metallic iron are strongly characteristic features of spathite in other regions, and in other lands. For example, the spathic ore of Cleveland, England, yields from 21 to 32 per cent. of metallic iron, has a specific gravity of 2.8 to 3.1 and the bed found interstratified in Middle Lias has an average thickness of 6 feet, and to produce a first class variety of Bessemer steel it is mixed with red hematite from Bilboa, Spain. Now the spathite of Tennessee, when mixed with two parts of brown hematite, makes an iron that commands the highest price.

Iron Ore in New Jersey.—From the report of the State Geologist, Trenton, New Jersey, we learn that the deposits of iron ore in the region, are of sedimentary origin, and it appears that the ferruginous mud, or suspended particles were carried by water into basin-like depressions and deposited, and after the cavity was filled it was in time covered with other sedimentary matter, and thus the whole series of these rocks are of sedimentary origin, although metamorphosed and of Algonkian age. It appears that "pitch and foliation replace each other," and this fact sustains the conclusions that different sections of the region were subject to greater and lesser lateral pressures, hence the greater rock waves that produce great pitching, and the lesser ripples of foliation.

We need not wonder then that pitch and foliation replace each other, or that where the one occurs, the other does not. The metamorphism and crystallization of these rocks as we now find them, to some extent obscures their real sedimentary origin.

Durability of Chalk Marks.

About five years ago an article appeared in one of the city papers stating that when the old city bell was taken down to be replaced by the new one chalk writing was found, plainly written 13 years before by a young engineer. In the year 1822 the bridge over the Big Gunpowder falls, at Ridgely's iron works, about 14 miles from Baltimore, was constructed by Robert Burr, considered at that time a famous architect and engineer of New Jersey. When the bridge was erected, several persons wrote their names thereon with chalk, and they can easily be read at this day, and the date, July 4, 1822. —*Philadelphia North American.*

Hon. W. L. Connell, mayor of Scranton and president of the Enterprise Coal Co., whose operations are near Shamokin, Pa., was on the 16th ult. presented with a handsome gold headed cane by the employes of the company. Mayor Connell, as president of the company, personally looks after the general management of the colliery, and the occasion chosen for the presentation was the date of the first operation of the new breaker, which replaced the one destroyed by fire on May 16th last. The employes testified their appreciation of the genial, fair minded and handsome mayor in a manner that shows his efforts in running the colliery harmoniously and profitably has made them among his strongest friends.

THE COPPER DEPOSITS OF MICHIGAN.

By M. E. Wadsworth, Ph. D., Director of the Michigan Mining School.

(Read at the Annual Convention of the Michigan Bankers' Association, September 12, 1895.)

In looking at the map of the Great Lake region, you have all noticed the backward bending thumb of Michigan projecting into the icy waters of Lake Superior; yet but few of you, perhaps, have realized that extending along that thumb there runs a band or ring of native copper.

It does not, like most gold or silver bands, extend around the finger, but along it—from the base of the hand to the end of the thumb—this central band lies imbedded in the flesh binding all together.

Shall we now dissect it, laying bare its flesh, muscle and bone, and try to explain its marvelous organization?

To do this it will be necessary to drop much of our simile and to make as clear as possible the geological structure of the district in question. Roughly, its central portion extending from the south-west to the north-east, may be said to be made up of an elevated plateau, bearing upon its wrinkled surface protuberances or hills, locally called mountains, like warts upon a finger.

Flanking both sides of this higher land lie lower lands extending down the to the level of the lake.

This lower level is formed of hardened beach muds, sand and shingle laid down on the shores of a tide-washed sea.

We find in it the ripple marks made by the waves, the mud cracks formed when exposed to the drying sun, and the prints of the soft rain drops that fell, at ebb, upon the gently sloping beach.

This formation is known to you all through its affording the beautiful Portage Entry or red sandstone, so much used now in building.

It is, however, with the central higher or Plateau region that we have the most to do with at present.

You are all familiar with the descriptions or with the sight of the lava beds of Vesuvius, or of Etna, or on Iceland or on the Sandwich Islands. You know how the lava flows onward towards the sea, now rolling with a rough, ropy, clinkery surface; and now gliding with a comparatively smooth one. This Lake Superior Plateau is composed of a series of lava flows like those from Kilauea, generally smooth but sometimes clinkery. Let us imagine a large sheet of ice extending over a lake, when from some cause a long fissure rends it open on one side, and the water wells up through the sheet and overflows the icy expanse. This overflow congeals; the ice is again rent in twain; a new overflow takes place, and so on until the ice continually sinking, is piled up in successive thicknesses, hundreds or thousands of feet.

Let us now more exactly explain what has taken place in Northern Michigan. The present promontory of Keweenaw Point once formed the gently sloping tide-washed shores of a sea. Over this shore poured the vast floods of lava, the same kind as now flows out from Etna, Kilauea, and the majority of active volcanoes of the present day. These flows, like those of Kilauea, were apparently quiet, and not explosive like those of Vesuvius and Etna.

At the time of the outpouring of those vast floods of lava, the shore was gradually sinking, so that the congealed rock was exposed to the action of the sea waves.

You all know of the effect of the storm-dashed waves upon a rock-ribbed coast, how the rock is torn down and worn away and then piled up along the shores as a resulting mud, sand, gravel and shingle.

In like manner our lava flows, along the shores of that great northern sea, where now Superior rolls were subject to the alternate tide and storm-waves, and to the action of sun, rain, wind and frost. The result of this all must have been, that the exposed portions of these flows were buried under their own debris, mingled with that of associated rocks. Besides the lava flows before mentioned, we find other flows and masses, similar in chemical composition to our granites, which being much harder and more enduring than the basaltic lavas, make up by far the larger portion of the debris now visible.

This region, then is composed of a series of interbedded basaltic lava flows, with their associated shingle, sand and mud now forming conglomerates, sandstones and shales.

In order to show more clearly what has happened since, let us take a new metaphor and look upon all these layers as forming a sort of marbled cake. Now let this cake be cut lengthwise along one side of the thumb-like mass, the cut extending north-east and south-west, nearer to the south-eastern side. Consider that the north-western part has been lifted up at a varying angle from 30° to 60°, and also cut across by fissures running north-west to south-east; and you have a fair idea of what has happened.

It is well known that in all regions where volcanic forces have been active, when these forces die out, hot water action is one of the last results, the waters gradually growing cooler until they are at the normal temperature, so that in time there is no evidence of the former hot state except that shown by its results on the rocks.

In the Lake Superior district the water action, mostly hot, sometimes cold, was strongly marked during the fissuring and movement, or as it is technically termed, "faulting of the rocks," as well as for a long time subsequently. During the time of this water action all the rocks, without exception, were penetrated by these percolating waters, much of their materials dissolved out, or chemically re-arranged, or removed and replaced by other elements.

It was then that the native copper now found in the rocks was stored up on its present banks of deposits, from which it is now being rifled by means of the drill, sledge, and dynamite. Three different systems of local deposit have been employed by Dame Nature on Keweenaw Point. The profound and repeated fissuring previously spoken of caused huge vaults to be made where the percolating waters left, securely locked up, their treasures of copper; and here the largest single deposits were made and the drafts have been fully honored. The vaults extend mainly in a north-west and south-east direction, cutting across the country. These deposits are technically known as fissure veins; and as examples there may be cited the Central, Cliff, Phœnix and other mines, mainly on the northern end of Keweenaw Point.

As one would naturally suppose, the various lava flows would differ in thickness, owing to the varying amounts of volcanic material erupted, as well as to the inequalities of surface. Like variation would also exist in the extent and amount of deposited conglomerate, shale and sandstone, on account of similar inequalities of the surface, the time it was in forming, and the area exposed to the tidal or wave action.

Returning to the lava flows, it has been found that the thinner ones are more glassy and hence more easily acted upon by the percolating waters; thus large amounts of the original rock materials have been dissolved out, removed and their places, as well as those of all other cavities, have been filled with deposits of copper and other mineral matter.

These deposits are mined and form the melapyr (locally called amygdaloid) mines, such as the Quincy, Osceola, Franklin, Atlantic, and Huron. These mines are worked on old lava flows that have been impregnated with copper, the same as a flow from Mount Etna might be worked, if it were likewise filled with valuable mineral.

Altogether it is popular to speak of these mines as worked upon veins, that is an error, as they have neither the structure of a vein nor any sign of a vein on or about them. They are simply flow deposits.

At the same time our fissure or vein and overflow deposits were formed, similar deposits were made in the interbedded detrital or sea-beach materials, or conglomerates. Here the percolating waters removed much of the cementing mud and the more easily soluble pebbles, filling in the places thus left with copper and other mineral matter. This form of deposit gives rise to our conglomerate mines, such as the Calumet and Hecla, Tamarack, Peninsula, and Allouez.

As before, these mines are not worked upon veins but upon old sea-beach shingle, the same as if any one of your beaches here, after having been covered up, should be worked for any mineral matter. They are not veins and they have no sign of a vein upon them; but they are simply bed deposits.

You may ask, whence came the copper now deposited in these three different kinds of safety vaults—vaults that were found by prehistoric man to be thoroughly fire-proof, but which are not burglar-proof, when attacked by the modern earth robber with power drill and dynamite.

No one can tell whence came this copper; he can only infer.

The largest amounts of copper are generally well within the series of lava flows, and associated with or underlying the thicker and heavier beds. Further, it has been seen that the general course of the copper was downwards, as it extends frequently like icicles, from the overhanging bed into the one that is worked, while sheets of it are wrapped around the angles of the broken blocks, like paper around a grocer's package. These and numerous other facts show that the copper was deposited from water subsequently to the fracturing and faulting of the rocks; and that it was probably originally disseminated through the lava flows and has since been concentrated in the various banks of deposit by the percolating waters, which penetrate all rocks.

Did time permit, the evidence in behalf of all the statements made here, could be laid before you—these evidences are picked up one by one by the earth's detectives, the geologists, who, like the Sherlock Holmes's, study the ashes, the mud, and every relic left by that thief, Time, in the depositories of old Mother Earth.

As you read the story of each coin and bill, each check and draft, so we read the story of each pebble and rock; and learn to ferret out the secret deposits of Dame Nature.

Electrical Mining Machinery.

The Link-Belt Machinery Co., Chicago are unusually busy in all departments of their Works at the present time, and especially so in the Electrical Mining Machinery Dep't. Contracts for this line of machinery have recently been closed with the following companies, Bessemer Land & I'mp't. Co., Bessemer, Ala., Electric Mine Haulage, consisting of 2 15x16'' McEwen Engines, 2 100 KW "Independent" Mine Type Generators, 2 80 H. P. "Independent" 4 wheel Locomotives, marble switchboard, circuits, etc.

Pittsburg Block Coal Co., Pittsburg, Pa. 2 6 ft. "Independent" Chain Breast Machines, 1 35 H. P. 4 Wheel Locomotive, 1 100 KW Dynamo, switchboard, etc.

Brazil Block Coal Co., Brazil, Ind. 1 100 KW "Independent" Mine Type Dynamo, 5 6 ft. Chain Breast Machines.

Joseph E. Thropp, Everett, Pa. 1 15x16 McEwen Engine, 1 100 KW Dynamo, 3 6 ft. Chain Breast Machines, 1 35 H. P. 4 Wheel Locomotive and necessary switchboards, circuits, etc.

In placing his order with the L. B. M. Co. Mr. Thropp takes the occasion to say that "after a thorough investigation of the mining machinery manufactured by the different companies by my superintendent, I have decided to accept your proposition for the complete equipment of my Kearney mines with dynamo, locomotive and coal cutters. I am fully satisfied your machinery is equal to, if not superior, for mine use to any we have examined.

New facts in welding by pressure at temperature below the melting points of the metals have been reported by the Royal Society of Belgium. Pressed together by hand-screws, cylinders of gold, lead and tin were well united in a heat of 200 to 400 degrees for three to twelve hours, bismuth and antimony less perfectly so. The more crystalline the metal the less was the softening.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as *Mine* Foremen, or to become *Mine Superintendents.*

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

The Central Orifice of a Fan.—The Three Orifices of a Fan.—The Correct Orifice for Measuring Quantities.—The Required Breadth of Fan Blades.—The Radial Length of Fan Blades.—The Loss by Wave Movements in Fans.—The Loss of Energy Due to Intermittent Action.—The Best Dimensions for Ventilating Fans.—The Laws of the Areas of the Fan Ports.—To Calculate the Diameter of a Fan.—Recapitulation of the Former Article.

76. The Central Orifice of a Fan.—Again we resume our investigation of the principles of action of the ventilating fan, and at the outset it is wise to refer to our last, by noticing that our conclusions were only arrived at by using an assumed value which we then called "the constant C," and gave it the numerical value of .6. We were careful, however to point out that .6 was used in lieu of .65 the constant for the *vena contracta* or the constriction or narrowing of a port or orifice through which a fluid is made to pass. The cause of the contraction is found in the inertia of the converging particles that choke the entrance of the port, and reduce its available area from 1 to .65.

Now, we did not take .65 but .6, and said that for reasons that we did not give then, the "constant was sometimes as low as .3." Therefore, before we can make further progress in our investigation it is important that we cast off the assumption and put in its place a correctly determined value. The constant .65 would require no qualification if the *correct* area of the port of entry into the fan was known, but this area is not easy to determine for two reasons, first, it will be seen by Fig. 117 that the area of this orifice is partly covered by

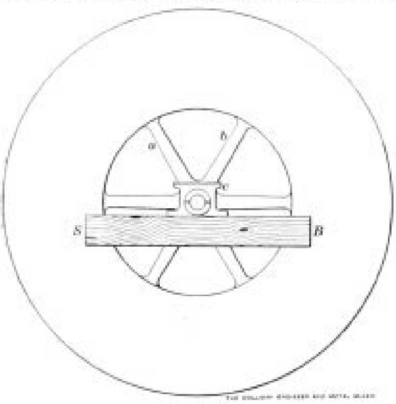


Fig. 117.

the spokes of the fan wheel, the carriage or bearing, and the shaft as at a, b and c and still further by the "main beam," $S\ B$; second, the spokes in their motion produce a whirl that still further reduces the area for the *free* entry of air, and the result is, with a port of entry that is relatively small, and largely obstructed, the constant, .65 is "sometimes reduced to .3," and this being so, we discover that the efficiency of a fan must be favorably or unfavorably affected by the lessor or greater obstruction that occurs at the port of entry, and as this is the case, it becomes all the more important that we should be able to estimate this available area, to enable us to calculate the ventilating power of the fan. If we defer the consideration of the estimate of the available area of the port of entry, until we have found what that area ought to be in a fan of good construction, then, we will be better able to make a correct determination.

77. The Three Orifices of a Fan.—There are three orifices in a fan that require attention and estimation, and these are the central orifice of entry, the entry at the throat of the fan, and the orifice of discharge at the circumference of the fan.

The central orifice of the fan ought to be as large as possible without being made to shorten the radial length of the fan blades; for if the blades are shortened the velocity of the fan must be increased, and then such an increase in the diameter of the central orifice becomes a defect, or one defect has been substituted for another, and it is therefore clear that there are to be found some proportions that jointly produce the best results. Let us then for the present assume a value that we will afterward prove to be the correct one, namely, that one square foot of area in the central orifice, should be provided for every 1300 cubic feet of air that are to pass through the fan per minute, or if Q is the quantity per minute, then $\frac{Q}{1300} = A =$ the area of the port of entry. Not many fans are found in which the ports are so large, but by constructing the fan to intake air at both sides, the required area can be provided without interfering with the length of the blades. The throat of the fan is the cylindrical orifice whose length is equal to the breadth of the blades, and whose

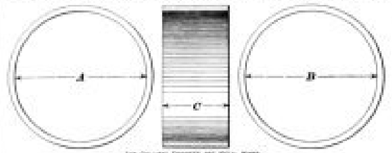


Fig. 118.

radius is equal to the radius of the central orifice of entry, see Fig. 118, and there C is a section of the throat cylinder, and A and B are supposed to be the dual cen-

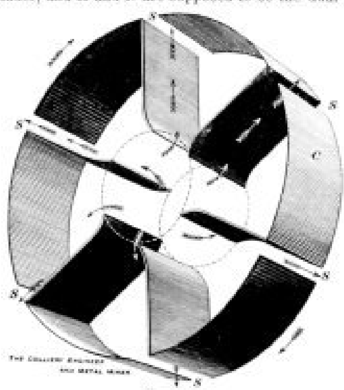


Fig. 119.

tral orifices of entry of a fan that takes in air at both sides. Now if the diameters of A, B and C are equal, then the area of entry at the throat of the fan, will be equal to the areas of A and B conjointly, and then the length of the throat area is equal to the radius of the central ports of entry, and when the air enters the fan at one side only, then the length of the throat area can be found by dividing the area of the central orifice by its perimeter, and the quotient is at once the length of the throat and the breadth of the blades.

The dotted lines in Fig. 119 are here introduced to illustrate what we mean by the term "throat area," and it will be seen to be the analogue of the surface of a cylinder which if too short, causes a constriction, and then the volume of air entering a fan can only be determined by this area, it being smaller than that of the central orifice, or orifices, or the orifice of discharge.

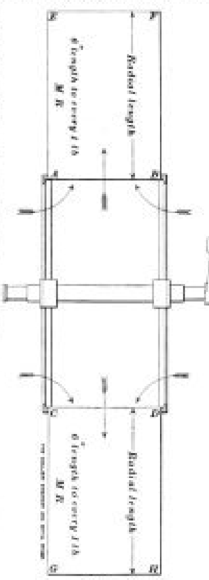


Fig. 120.

78. The Correct Orifice for Measuring Quantities.—While this fact is before us let us repeat in a decisive manner that in every case, the quantity of air flowing through a fan must be found with the smallest of the three orifices, that is, the central, the throat, or the discharge orifice; and to make no mistake about it let us call the smallest orifice d, and therefore, if the area of the central orifice is the least, then it is d, or if the throat area is least, then take it for d, or if the orifice of discharge is least, take it for d, as for example in the case of a Guibal fan where the area of discharge, or that uncovered by the shutter is generally smaller in area than the orifice of entry.

79. The Required Breadth of Fan Blades.—So far then we are in a position to calculate the breadth of the fan blades by taking for our unit of the intake areas the assumed number 1,300, and relying on it until it is proved to be correct, let us proceed to find the central and throat areas, as follows: When the required volume of the ventilation is 150,000 cubic feet of air per minute, then $\frac{150,000}{1,300} = 115 +$ square feet the areas required. If the air enters at one side only, then the diameter of the central orifice is $\sqrt{\frac{115}{.7854}} = 12.1$ feet, or if it has two central orifices their diameters will be $\sqrt{\frac{115}{.7854 \times 2}} =$ 8.56 feet.

Now in the first case for a single orifice the breadth of the blades should be as follows: $\frac{115}{12.1 \times 3.1416} = 3.025$ feet, and in the second case the breadth of the blades for two central orifices should be $\frac{115}{8.56 \times 3.1416} = 4.276$ feet.

No doubt can be entertained concerning these calculations, but our great aim just now is to forewarn and forearm our readers about the possibility of the area in the throat of a fan being the smallest, and, therefore, the gauge by which quantities passing through the fan are to be measured.

No advantage is gained by making the area of the throat greater than that of the central intake, but a great advantage is gained by producing a large central area of intake with a minimum radius, because this provision does not reduce the radial *length* of the blades as shown in Fig. 120 at $A\ E$ and $C\ G$. The breadth of the blades is seen to be equal to $A\ B$ and $C\ D$. The diameters of the orifices of entry are seen to be equal to $A\ C$ and $B\ D$.

80. The Radial Length of Fan Blades.—The thing, however, of the greatest importance in this figure is the radial length of the blades, and the scale that determines this proportion is derived from the mine resistance, and, therefore, to secure the best results with the

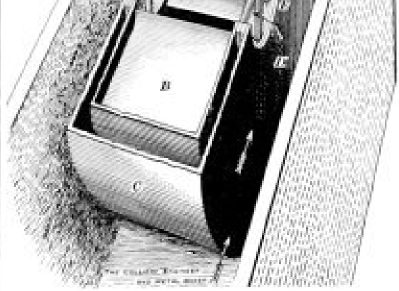


Fig. 121.

lowest peripheral velocity, we find that for every one pound on the square foot of mine resistance, at least six inches should be given to the radial length of the fan blades, and this fact, coupled with that of the area of the orifices of entry, establishes the negative and positive conclusions, that if the orifices of entry are too small to obtain a given volume of air, the fan must run faster to generate within itself a greater depression, and if the blades are too short, then the fan must run faster to make the required depression. Here, then, we can no longer doubt the propriety of large orifices of entry, and we further see that short blades in a fan give a short motive column, and positively, therefore, the larger we make the area of intake and the longer we make the blades, the lower will be the peripheral velocity at which the fan will do its work. Fig. 121 is an illustration, partly in plan and partly in perspective, of a ventilating fan constructed to intake air at both sides, as at P and E. Two of the blades are marked B and B. The fan is covered with a case C, built in the fan drift D and D. A glance at the figure shows at once the advantage of the double entry and the large blades, but here the word *large* suggests the possibility of something being overlarge, and as assumptions are of little value unless they can be afterward sustained, let us try to discover when the blades of a fan are over large, and when they are too small, and thus remove the ambiguity from the assumed number 1300, out of which we determined the area of the central and throat ports of entry, and the breadth of the blades. First then to make the blades too large, let us use two large fans to do the work of one, the mine resistance being the same for two as for one. This being the case, two fans would not, and could not in any way increase the volume or quantity of air circulating in the mine, because to increase the quantity, the velocity, the resistance, and the pressure must all be increased, and you cannot increase the one without increasing the other. Again as the blade surface is increased the velocity of the fans will be reduced, and the question arises, how much? Let us suppose that the velocity of one fan is 80 revolutions per minute, and that with that speed the total difference of potential between the ejected air, and the depression in the fan drift is 13 pounds per square foot, the mine resistance being 10 pounds per square foot. Now if we set two fans to do the same work as the single one, the mine resistance for the same quantity at the same velocity in the mine will still be 10 pounds per square foot, and all the two fans can do, is, to reduce the difference $T - M = 13 - 10 = 3$. Now the reduction by the two fans will be as $\frac{1^2 \times 3}{2^2} = \frac{1 \times 3}{4} = .75$, therefore, with the two fans T would *appear* to be 10.75, but with such a small difference of potential, other and serious resistances arise in the running of the two fans.

Now on the face of it there appears to be a real advantage gained by practically doubling the area of the blades and that of the ports of entry, because only half of the air is entering each of the two fans, that previously passed through the port of entry and along the blades of one fan; and further, if no new resistance interfered, the velocity of each of the two fans would be, if the single fan was 80 revolutions per minute, $\sqrt{\frac{10.75 \times 80}{13}} = 72.72$ revolutions per minute, and we now see that by still further increasing the number of fans, or the sizes of the ports and blades of one fan, the difference between T and M might be reduced almost to nothing. But another enemy of these subtle refinements steps in and calls halt!!, and that is the "state of instable equilibrium."

81. The Loss by Wave Movements in Fans.—With large ports of entry and discharge, the difference between T and M becomes very small because the air enters and leaves the fan or fans at a very low velocity, and let us suppose by way of illustration that we have six fans doing the work of one. Now the mine resistance would be the same for six as for one fan, therefore if one fan made 80 revolutions per minute, each of the six would have to make at least 70 revolutions per minute to sustain the required depression. It is true that only one sixth of the air would pass through one of the six fans, that would pass through the fan that did the whole of the work, and it might therefore be thought that the six fans would conjointly do no more work than the single fan; but this is not so, because the difference between T and M has become less than one pound on the square foot, instead of three pounds as before and the result is the smallest variation in the velocities of the engines produces wave motions that considerably increase the work to be done.

82. The Loss of Energy Due to Intermittent Action.—When resistance has to be overcome by intermittent efforts, the loss of effective energy is considerable, and to explain fully what we mean Fig. 122 is

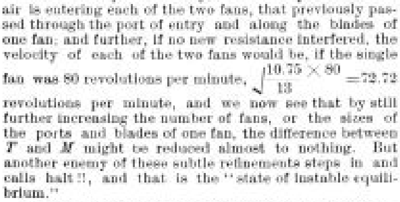


Fig. 122.

introduced. A and B are two rowers who apply their energy intermittently with their oars; now the resistence that a boat meets with in progressing through water varies as the *cubes* of the velocities and therefore the velocities vary as the cube roots of the powers, and it is now our business to show that a force continually applied, propels a boat at a greater mean velocity than the same force would do applied intermittently, for the following reasons that will be given in proportionate, instead of actual values. Suppose then a rower applies for the propulsion of his boat a power of 125 units of work every alternate second of time. We see that during one second 125 units are applied, while during the next second the momentum of the boat and its load is consumed in its own propulsion, it therefore follows that the mean velocity of the boat will be $\sqrt[3]{125} \div 2 = 2.5$. But if $\frac{125}{2} = 62.5$ units of work are applied continuously instead of 125 intermittently, the mean velocity will be $\sqrt[3]{62.5} = 4$ nearly. Or while a continuous power will propel the boat 4 miles, the same power applied intermittently will only propel it 2.5 miles. Now what is true of the boat is also true of the fan, for the power producing mine ventilation varies as the cubes of the velocities, and as a jerking pulse, or wave motion takes place in the air stream flowing through a fan in which the orifice of discharge is *too large*, and therefore the difference between T and M is *too small*, we have a cause of intermittent action as in the boat. All mine currents move pulsatively, and very markedly so, when the resistance is considerable, and when therefore the difference of potential already referred to is small, the jerky pulsations of the mine current enter the fan and react on the engine, and the result is, such a fan, as an open one with a *very large* area of discharge, gives out a small percentage of efficiency. The loss of energy in the fan often arises from another cause, as where the blades are too short, and therefore the fan has to be run at a high velocity to obtain the required difference of potential, and the result is the velocity of the fan is constantly varying as the engine passes through full crank, and the dead points.

It was to remedy this very pronounced wave motion in the Guibal fan, that the Walker shutter was introduced. The wave movements in a fan sometimes synchronise and the result is a loud note. The writer has heard the loud moaning, or roaring sound of a fan at the Letch Colliery near Moorsley, County Durham, England, a mile away.

83. The Best Dimensions for Ventilating Fans.—To secure good results in a fan then, the blades must be of sufficient length and breadth to prevent the loss due to wave motion; and to make the difference between T and M sufficiently large, the areas of the orifices of entry and discharge must be made such a size that they will on the one hand reduce resistance, and yet on the other hand not make that resistance so small that the difference of potential will not be sufficient to prevent the instability of equilibrium. The areas that secure the best results then are for the central port of entry $\frac{Q}{1300} = A$. Here Q is the required ventilation in cubic feet per minute, 1300 a constant, and A = the area in square feet. For the throat of the fan $\frac{Q}{1300} = A$, and for the port of discharge $\frac{Q}{2600} = a$.

To find the breadth of the blades of a fan, divide $\frac{Q}{1300}$ by the circumference or perimeter of the central port of entry and the quotient will be the required breadth of the blades correctly.

Fig. 123 is given to clearly establish in the mind of

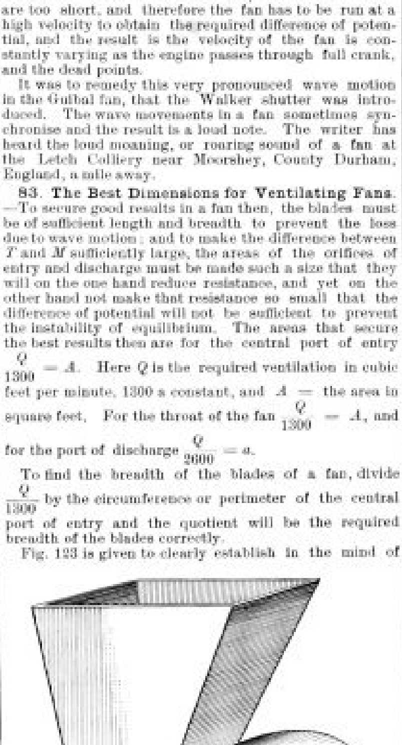


Fig. 123.

the reader the characteristic depressions and the pressure of discharge as exemplified in the action of the fan.

First. The depression in the fan drift measured by the gauge D D.

Second. The depression in the fan as shown by the gauge F D.

Third. The pressure of discharge as indicated by the gauge S P.

Now to understand the values of the three measurements, call the depression for injection i and the compressions for ejection e, then $M - i + e = T$, or $T - M = e - i$, assuming that $M - i$ is the zero of pressure. When the port of entry is equal in area to the port of discharge, then the depression below M is equal to the compression above the atmosphere, and then the air passing through the fan moves pulsatively, and when the area of discharge is greater than that of the intake as in the open running fan, then the air flowing through the fan dances tumultuously and wastes the energy that should do useful work. Further, when e is at a higher pressure above the atmosphere than i is at a pressure below M, then the fan does its work with economy.

84. The Laws of the Areas of the Fan Ports.—Fig. 124 furnishes to the eye at a glance the conviction that the air passing up the upcast shaft S will never be greater than that due to the pressure producing the ventilation of the mine, and therefore, if one, two or twenty fans, were made to exhaust out of the same drift, unless their velocity was such as to first balance the mine resistance, which might be say 10 pounds per square foot, the velocity of the mine current would reduce, and although i and e, would both be reduced, because the united areas of the ports of entry would conjointly make

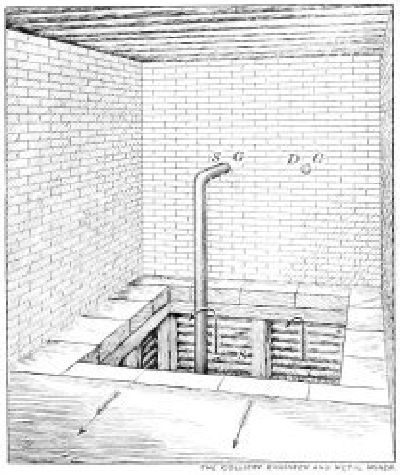


Fig. 124.

a large one, and the united areas of the ports of ejection would do the same, yet the loss of energy would be considerable, as the result of the united port of discharge being *over large*, and e being too small to check the intermittent flow through the fans. It does seem to be a paradox that two fans should make nearly the same number of revolutions as a single one, and yet exhaust no more air from the mine, and yet it is so, and we have made the reason plain by posing and transposing, until we have found x.

Before leaving this figure let us notice another interesting feature in it, namely, the water gauge connections as DG, that is made to measure directly the depression in the fan drift, and SG that measures the depression due to the mine only. A pipe from SG is carried 20 or 30 feet down the shaft, and always gives a *little* less reading than DG.

85. To Calculate the Diameter of a Fan.—The diameters of fans for exhausting certain volumes of air can be found as follows, but, let us first notice that the dimensions furnished by the rule are reliable deductions.

Let Q = the ventilation in cubic feet per minute, then $\sqrt{\frac{Q}{200}} = D$. D being the diameter. Suppose then we require a fan for a quantity of 200,000 cubic feet of air per minute, then $\sqrt{\frac{200,000}{200}} = 31.16$ feet the diameter of the fan required.

Or the rule is, divide the required quantity in cubic feet per minute by 200, and the square root of the quotient is the diameter of the fan required.

86. Recapitulation of Facts.—1. Obstructions in front of the orifice of entry reduce the constant .65.

2. There are three ports in a fan, namely, the central, the throat and the port of discharge, and the smallest of these must be taken for calculations.

3. To find the volume of air passing through a fan, multiply the smallest of the three ports in square feet, by the calculated velocity of the air in feet per minute, and the result will be the volume of the ventilation in cubic feet of air per minute. Note carefully, the orifice taken must be the least of the three.

4. To find the *minimum* radial length of the blades of a fan, allow 6 inches in the radial length, for every pound in the pressure per square foot of the mine resistance. If possible, 7 inches per pound of resistance is best, because it gives a lower peripheral velocity. Suppose the resistance to be 10 pounds per square foot, then $10 \times 6 = 60$ inches, or five feet, the required radial length of the blades.

5. The area in square feet of the central orifice or orifices of entry should be, when Q stands for the quantity of air in cubic feet per minute, $\frac{Q}{1,300} = A$ = area of port of entry.

6. The area in square feet of the cylindrical entry in the throat of the fan should be $\frac{Q}{1,300} = A$ = area of the throat.

7. The maximum area of the port or ports of discharge should be $\frac{Q}{2,600} = A$.

8. The diameter required for a fan should be $\sqrt{\frac{Q}{200}} = D$.

9. The loss that arises when a ventilating force is applied intermittently is the result of wave motion.

10. The small advantage obtained by setting two or more fans to do the work of one, is the result of M remaining the same for an unaltered velocity.

87. Recapitulation of the Former Article.—First, to obtain T, find the diameter of gyration by the following method: Add to the diameter of the central port of entry the radial length of the blades, and the sum is the required diameter of gyration. Suppose the diameter of the central port of entry is 10 feet and the radial length of the blades is 5 feet, then $10 + 5 = 15$.

To find the velocity of the center of gyration in feet per second, and also T, when the velocity, diameter, areas of the ports and lengths of the fan blades are given.

Let $W = .0766 \times B$, B being the length of the fan blades.

v = the velocity in feet per second.

g = the gravitation unit 32.16.

P = the total pressure in pounds per square foot of the tangential force produced by the fan. Then $\frac{W v^2}{3.1416\, g} = T$. As an example, let the diameter of the fan be 20 feet, the length of the blades 5 feet and the number of revolutions per minute 70. Now, to generate a constant that will ever after save time and trouble, let us make a full statement, and let the letter c be set before every *recurring* factor, and then we can proceed at once with the reduction, as

$$\frac{15 \times c\,3.1416 \times 70 \times 15 \times c\,3.1416 \times 70 \times 5 \times c\,.0766}{c\,60 \times c\,60 \times c\,3.1416 \times c\,32.16} = T.$$

Now the constants in the order of their places in the dividend and divisor are

$$\frac{3.1416 \times 3.1416 \times .0766}{60 \times 60 \times 3.1416 \times 32.16} = .00000208.$$

The true result is .0000020785528, therefore, .00000208 is a little too much, but in this form it is easy to remember. Now to find T, let

B = the length of the blades in feet,

R = the revolutions per minute;

D = the diameter of gyration in feet;

C = the .00000208.

Then $B R^2 D^2 C = T$, or $B R^2 D^2 \times .00000208 = T$, and in the case suggested $5 \times 15^2 \times 70^2 \times .00000208 = 11.466$ or we may say that T is equal to 11.466 pounds pressure per square foot above the depression in the fan drift.

Second. To find the velocity in feet per second of the air entering or leaving a fan, the number 1,800,000 was introduced to expedite the calculations, and it was shown that this number represents the square of the velocity in feet per second of air rushing into a vacuum; and it was further shown that the squares of all other velocities are in the same proportions to 1,800,000, as the pressures that generate them. For example, suppose the pressure setting air in motion is equal to 4 pounds per square foot, and if in this case there are no qualifying factors that interfere, like the depression in the fan drift, or the still greater depression in the fan itself, then the squares of the velocities will be directly in proportion, as 4, the pressure per square foot given, to 2120 the pressure in pounds per square foot of the atmosphere,

then $\frac{4}{2120} \times 1,800,000 = 3396.2264$. This means that a pressure of 4 pounds per square foot sets air in motion with a velocity, whose square is 3396.2264, or with a velocity that is equal to $\sqrt{3396.2264} = 52.277$ feet per second.

It would be noticed in our last lesson that the equivalent of the pressure of the atmosphere was given as 2130 instead of 2120. The reason of this is the 10 pounds are added to balance a slight variation with regard to the center of gyration, and thus prevent a very intricate calculation that would be required to correct a relatively small error.

Third, it was shown that the rush of air into the orifice of entry of an exhaust fan, could be calculated by the expression $\frac{(T - M) \times 1,800,000}{(2130 + M^2)} = v^2$, and that the expression for a blowing fan was $\frac{(T - M) \times 1,800,000}{(2130 + M)} = v^2$. Further it was shown, that the velocity in feet per second multiplied by 60 for feet per minute, and that product multiplied by the area of the orifice of entry in square feet, gave the cubic feet per minute passing through the fan.

Fourth, it was explained that the density of air varied inversely as the temperature, and directly as the pressure, and that the weight of air entering a fan was always equal to the weight of air discharged by it, but the velocity of the air entering a fan was always greater than the velocity of that discharged and in the case of an exhaust, the squares of the velocities were in the proportion of $\frac{T - M}{2130 + M^2}$ and for a blowing fan $\frac{T - M}{2130 + M}$.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

68. Electric Modes of Action.—Electric energy is characterized by four phases that are known as positive, negative, static, and dynamic electricity, and all the manifestations of this force are the resultants of the conjoined action of all the phases. For example, positive electricity is attracted by the negative phase, and therefore when the static positive particle is attracted by the negative static particle, their approach becomes a dynamic manifestation. Static electricity is the mode or phase of the force that takes the form of potential or static energy, and may become dynamic or kinetic, or active, or transposed force, according to the conditions that control it, for example Fig. 111 is an applied illustration of what is meant, and here the monkey or drop weight of the pile driver is raised by a chain subject to a *static* strain equal to the gravity of the monkeyweight. In the weight itself energy is in the course of being stored up potentially during the period of lifting, and when the weight reaches its highest elevation it is detached from the chain by being unfastened automatically, when it descends as a dynamic force or the medium of kinetic energy. If a weight falls it is capable of exerting great force through a small distance, but the foot pounds of energy developed never exceed what is due to the earth's attraction.

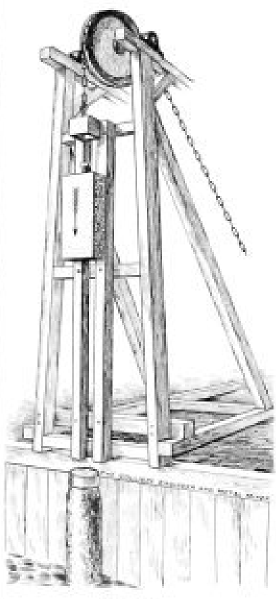


FIG. 111.

Energy in this case is inert, and for that reason *foot* pounds become *inch* pounds, if the force is consumed by its exertion through one inch of space. For example, if 100 pounds fall from an elevation of 100 feet then the energy stored up in the moving mass is equal to 10,000 foot pounds, that is to say this falling body can exert a mean force of 10,000 pounds through the space of one foot, or a force of $10000 \times 12 = 120,000$ pounds through the space of one inch, or a force of $120\,000 \times 8 = 960,000$ pounds through the space of an eighth of an inch, or a force of $120,000 \times 100 = 12,000,000$ pounds through the one hundredth of an inch. We see then that the force stored up in a moving mass could be infinitely multiplied, through an infinitely small space, but for the elasticity of matter within the range of molecular attraction.

Static electricity is only another mode of inert force, and in every respect is the result of the operation of the same mechanical laws, and its mode of action should therefore be known, if we wish to acquire a useful knowledge of electrical appliances; for example, in the transmission of electrical energy for the purpose of doing work in mines, we are doing very well, if 50 per cent. of the horse power of the steam engine driving the generating dynamo is utilized in useful work, and we may therefore inquire what has become of the other 50 per cent. that is lost, and the answer is, it has been dissipated as heat developed by the resistance produced by static induction, for you cannot send a current of dynamic and yet intermittent or pulsating electricity through a wire without starting and stopping the synchronic motions of the constituent molecules, the result is, the manifestation of an opposing inert force.

If you do not understand the laws of static charge, you will try to do what is impossible, that is to recover the lost 50 per cent. of work, and if you understand the resistance due to static charge you will seek to improve electric generators by reducing the intermissions in the inducing impulses, so as to minimize the loss due to molecular inertia. A flash or electric discharge of static electricity from a cloud will split a tree, and rend and shatter the noblest artificial structures, but it is after all, only an example of a relatively small inert force, exerted through a small distance such as the expansion of the sap in the vesicles of the wood of the tree, and the expansion of the metal binding, or the moisture in the mortar in the joints of the stones of a building, or even in the stones themselves. Fig. 112

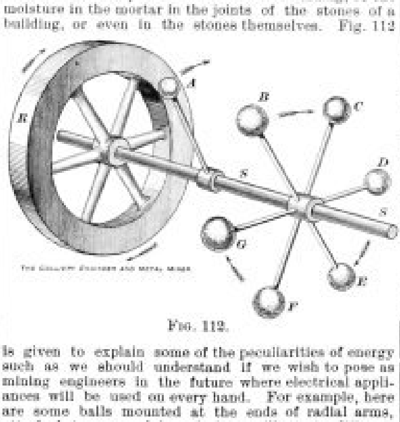


FIG. 112.

is given to explain some of the peculiarities of energy such as we should understand if we wish to pose as mining engineers in the future where electrical appliances will be used on every hand. For example, here are some balls mounted at the ends of radial arms, attached to a revolving shaft, to illustrate different electric voltages or pressures and the corelated coulombs or masses.

The particle A, may then be taken as one ampere, and its velocity may be such as to develop one joule of energy, which may be given out as pressure through a foot, an inch or less, or more, and what is said of A may be said of B, C, D, etc., with the correction in view that energy stored in six masses would be six times greater than that stored in one, and, therefore, the energy stored in the wheel R, would be as many times greater than that stored in the ball A, as R is times heavier than A. Here, however, is the puzzle. When these masses attain a stationary velocity they cease to accumulate energy, and they cannot give out ever so small a fraction of this energy without losing a portion of their velocity, so that for the balls and the wheel to take in and give out energy, their velocity must be alternately accelerated and retarded, or their motion, instead of being uniform, must be intermittent; and this peculiarity characterizes all electrical actions.

For example you cannot send an electric current through a cable, and the molecules of the wire remain at rest; and further we see, that if the molecules have a uniform rotary motion, they could not transmit energy; therefore, the molecules to continue the transmission must have an alternate vibration, and such is actually the case. Indeed the current is generated by the alternate movements of the poles of the armature of the dynamo. Fig. 113 is to illustrate the curious manifestations of continuity and alternation such as take place in an electric conductor.

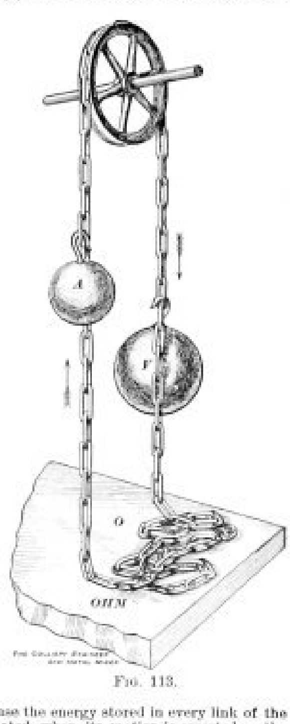


FIG. 113.

Here a chain passing over a pulley is used to illustrate the points before us. First we have an illustration of uniform velocity, the descending weight V does not accelerate in falling, because the energy stored in every link of the chain is dissipated when its motion is arrested on the slab O, and the energy of V is balanced by setting in motion the links in succession on leaving the slab, and the loss of energy due to the stopping and starting of the links is the analogue of that waste of electrical energy, that is measured by ohms, and is shown in a graphic manner by the piles of links at rest on the slab at *OHM*. We cannot close this lesson, however, without drawing attention to the great fact in relation to electric conductors, namely, they always consist of metals or their alloys, or simple bodies such a carbon, in which the vibrating or alternate movements of the molecules, can synchronize as electric waves.

[TO BE CONTINUED.]

MINING METHODS.

The Inertia of Moving Air.—The Pressure and Velocities of Air Currents.—Inertia of Air in the Shafts of Mines.—Measuring the Force of the Wind.—The Pressure of the Wind.—Regulator Experiments.

66. The Inertia of Moving Air.—Nothing is more important in the study of mining subjects than the acquisition of applied or practical knowledge in relation to the laws of air in motion, and we therefore now propose to so treat the subject as to make the numerical values we ought to know, clear and intelligible.

The force required to make air move or to arrest its motion, varies as the squares of the current velocities. That is, if you double the *square* of the velocity you require double the pressure to produce that result, and perhaps the best explanation will be found in applicate examples. First then, the square of the velocity of air rushing into a vacuum, is equal to 1,800,000, or it may be said that air rushes into a vacuum with a velocity of 1341.6411 feet per second.

Now as the pressures vary as the squares of the velocities of moving air currents, it is clear that if we knew the pressure per square foot at which air at atmospherit pressure rushes into a vacuum, we could with differenc pressures find the squares of the velocities coincident to to these pressures.

For example, the pressure of the atmosphere in pounds per square foot is 2120, and with the aid of a clear knowledge of the laws of energy and the values 1,800,000 and 2120, we can find the pressure due to the inertia of air moving at any velocity, or having the pressure given, we can find the velocity in every case.

67. The Pressures and Velocities of Air Currents.—Suppose the pressure per square foot of an air current is equal to 8 pounds, what is the square of the velocity that generated this pressure? The following simple statement will be sufficient to establish the conclusion by convictior, for it is clear, the 8 pounds are only a small fraction of the 2120 pounds and that 2120 will be in the same proportion to 8, that 1,800,000 is to the square of the required velocity, then $\frac{8}{2120} \times 1,800,000 = 6792.4516$ the required square, and the velocity in feet per second will therefore be $\sqrt{6792.4516} = 82.4166$.

We might ask the question, what pressure per square foot will set air in motion at the rate of 82.4166 feet per second? Now we know that the pressures vary, not as the velocities, but as the squares of the velocities in feet per second, and as the square of 82.4166 is 6792.4516., this square must be a fraction of 1,800,000 and therefore $\frac{6792.4516 \times 2120}{1,800,000} = 8$ nearly, or as the decimal portion of the number 6792.4516 in not finite, the result appears a very small fraction under its value.

68. Inertia of Air in the Shafts of Mines.—In the upcast shaft of a mine ventilated with a fan many experiments can be tried to demonstrate the laws of energy in relation to air currents, and to strengthen the evidence of the fact Fig. 115 is introduced. Now, let the round

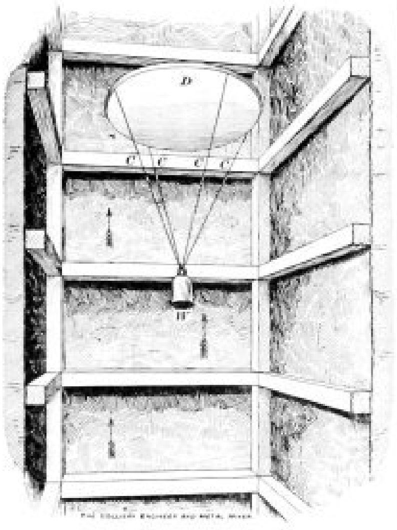


Fig. 115

disc of wood D be two feet in diameter, and let it and the cords c, c, c, c, and the weight W weigh all together 10 lbs.

From the standpoint of ordinary observation, say the flying of a kite, 10 pounds seems a great weight but in the open air the currents we most commonly observe are parallel to the plane of the horizon and therefore the direction of their motion is not favorable for lifting weights, but in the case before us, the current has a vertical upward motion, and therefore, advantage can be taken of the energy of this current for lifting the weight in question. First then, let us find the area of the disc in square feet and then from this number of square feet we will be able to find the weight per square foot to be lifted. The disk is 2 feet in diameter, then, $2^2 \times .7854 = 3.1416$ square feet and the weight to be lifted per square foot is $\frac{10}{3.1416} = 3.183$ pounds.

The velocity of the air in feet per second to lift this weight then is $\sqrt{\frac{3 \cdot 183 \times 1,800,000}{2120}} = 52$ nearly.

69. Measuring the force of the wind.—Fig. 116 is to illustrate the deflection of a board whose length $C A$ is 24 inches, and breadth 18 inches, and and total weight 7 pounds. This figure furnishes a good example for the training of the judgment to deal with questions relating to the inertia of fluids, and therefore let us suppose that the conditions of the problem are, in addition to those already given, that the board is by the force of the wind blown 30° out of plumb, and that we require the velocity of the air that produced this deflection.

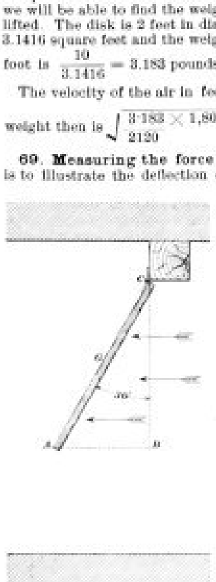


Fig. 116.

First find the weight per square foot of the board, thus $\frac{2 \times 1 \cdot 5}{7} =$ ·42857 of a pound.

Second as the board is suspended at the edge C, the wind will only lift half its weight, because the centre of gravity G is situated midway between C and A, therefore the weight lifted by the wind will only be $\frac{.42857}{2} =$ ·214285 of a pound.

Third the fraction of the weight lifted by the wind, will be directly proportionate to the sine of the angle $A C B$, then the force of the wind per square foot vertical will be, Sine 30° × ·214285.

Fourth, the length of the surface on which the wind impinges will be proportionate, not to $C A$ but to the cosine of the angle $A C B$, then the pressure deflecting the board per square foot vertical, will be

$\frac{\text{Sin } 30° \times \cdot 214285}{\text{Cos. } 30°}$ = the pressure required, but $\frac{\text{Sin}}{\text{Cos}}$ = Tan, then the Tan 30° is .5773503 and the pressure per square foot is .214285 × .5773503 = ·12372 of a pound, and the velocity of the air current that will deflect a board 2 feet long and 1.5 feet broad and weighing 7 pounds, from the plumb line, through an angle of 30°, must be $\sqrt{\frac{\cdot 12372 \times 1,800,000}{2120}} = 10 \cdot 25$ feet per second.

It is not necessary that the angle through which the board is deflected from the plumb line should be known, because if the horizontal distance through which the board is moved is found to be 12 inches as from A to B, and the length of the vertical or cosine line $C B$ is found to measure 20.7846 inches, then the tangent can be found at once, as $\frac{12}{20.7846} = .5773503$. All we have to do is to multiply half of the weight of the board by this tangent and then proceed to find the square of the velocity as already explained.

Suppose the length of the vertical line $C B$ is 12 inches and the length of the horizontal line $A B$ is 20.7846 inches, and the weight and dimensions of the deflected board are as before, then the tangent of the vertical angle $A C B$ is $\frac{\text{Sin.}}{\text{Cosin}} = \frac{20.7846}{12} = 1.73205$, and we find the pressure per square foot of the wind that would thus deflect the board is .214285 × 1.73205 = .3711523 pound, and the required velocity is therefore $\sqrt{\frac{.3711523 \times 1,800,000}{2120}} = 17.75$ feet per second.

70. The Pressure of the Wind.—Fig. 117 is an illustration that is co-related in principle with the other examples already given, and the aim of the figure is to

Fig. 117.

show how the volume of air passing through a regulator may be found with the help of the water gauge. Suppose then that the regulator shutter is open to the extent, that it uncovers an area of 2 square feet, and that the difference in pressure between one side and the other of the regulator stopping is equal to one inch of water gauge, what volume of air in cubic feet per minute will pass through this regulator?

To solve this problem, first find the velocity in feet per second that would generate a pressure of 5.2 pounds on the square foot, as $\sqrt{\frac{5.2 \times 1,800,000}{2120}} = 66.446$, the velocity in feet per second; second, the volume of air passing through the regulator can be found by multiplying the velocity per minute by the area uncovered in square feet, and by the equivalent of the *vena contracta* .65, and 66.446 × 60 × 2 × .65 = 5182.8, the cubic feet of air per minute passing through the opening in this regulator shutter.

71. Regulator Experiments.—To understand the principle of action of the regulator let us try an experiment with one, and discover what takes place when the shutter uncovers different areas for the passage of different volumes of air, and therefore in the first place let us assign values for the airway in which the regulator stopping is fixed.

1. The length of of the airway is 900 yards.
2. The section of the airway is 6 by 10 feet.
3. The volume of air passing before the regulator stopping was interposed was 36,000 cubic feet per minute.
4. The difference of pressure or the difference of potential between the opposite ends of the airway is equal to 1 inch of water gauge or 5.2 pounds pressure on the square foot.
5. The volume of air passing through the uncovered area of the regulator is 3,600 cubic feet per minute.
6. The vertical depth of the shutter is 16 inches.

Experiment one. Find how far open the regulator shutter must be for the passage of this quantity.

First notice that if 3,600 cubic feet pass through the shutter they also pass through the airway, and will therefore encounter a resistance from this cause, which will be proportionate to the squares of the quantities, and it follows that the difference of potential for the opposite sides of the regulator stopping will now be as $5.2 - \left(\frac{5.2 \times 3,600^2}{36,000^2}\right) = 5.2 - \left(\frac{5.2 \times 1}{100}\right) = 5.148$ pounds.

Second, notice that the velocity through the regulator must be $\sqrt{\frac{5.148 \times 1,800,000}{2120}} = 66.113$ feet per second, or per minute 3966.78 feet, and allowing .65 for the *vena contracta*, the square feet in the orifice of the regulator will be $\frac{3,600}{.65 \times 3966.78} = 1.3962$, and as the vertical depth of the shutter is 16 inches the amount it is open will be $\frac{1.3962 \times 144}{16} = 12.566$ inches.

Experiment second. Find how far the regulator shutter should be open for the passage of 20,000 cubic feet of air per minute, all the dimensions being the same as before. Then,

$$5.2 - \left(5.2 \times \frac{20,000^2}{36,000^2}\right) = 5.2 - \left(5.2 \times \frac{25}{81}\right) = 3.6,$$

then, $\sqrt{\frac{3.6 \times 1,800,000}{2120}} = 55.2865$, the velocity in feet per second, and the velocity per minute is 3317.19. The opening of the regulator then, is equal to

$$\frac{20,000 \times 144}{.65 \times 3317.19 \times 16} = 83.481 \text{ inches.}$$

Experiment three. Let the dimensions be the same as before, except those of the shutter, because the result will be too large for inch measure, and let us now calculate for a quantity of 30,000 cubic feet of air passing through the regulator per minute, then,

$$5.2 - \left(5.2 \times \frac{30,000^2}{36,000^2}\right) = 5.2 - \left(5.2 \times \frac{25}{36}\right) =$$

1.589 pounds, then, the velocity in feet per second must be as $\sqrt{\frac{1.589 \times 1,800,000}{2120}} = 36.731$, and the velocity per minute is 2203.847, then, $\frac{30,000}{.65 \times 2203.847} = 21$ square ft.

Experiment four. Continue the same dimensions, and let the volume passing through the regulator be 35,000 cubic feet of air per minute, then,

$$5.2 - \left(5.2 \times \frac{35,000^2}{36,000^2}\right) = 5.2 - \left(5.2 \times \frac{1225}{1296}\right) =$$

.285 pounds, and the velocity in feet per second will be $\sqrt{\frac{.285 \times 1,800,000}{2120}} = 15.556$, and the velocity per minute is 933.35, then, the opening required in this regulator is $\frac{35,000}{.65 \times 933.35} = 57.692$ square feet.

By these four experiments with the regulator, we learn the true principles of its mode of action, namely, the difference of potential on the opposite sides of the regulator stopping varies in the following proportion, when P is the difference of potential for the entire airway, and Q is the quantity through the unobstructed airway, and q is the quantity passing through the regulator, then $P - \left(P \frac{Q^2}{q^2}\right) = p$, for in this case p is the difference of potential at the regulator. It is clear then, that as the velocity in the airway increases, the difference of potential at the regulator decreases, and at last the constriction of the regulator vanishes, as in example four where we see, just as 35,000 is nearly 36,000 so 57.692 square feet are a very near approach to 60 square feet.

The most important lessons learned by these experiments are, first, as we have just seen, that the regulator vanishes into the equivalent orifice; second, that the volume of air passing through a regulator *cannot* be correctly calculated unless we can first determine the difference of potential, or the difference of current pressure on the opposite sides of the regulator stopping.

[TO BE CONTINUED.]

Pitch Glaciers.

Professor W. J. Sollas recently gave an address on "Pitch Glaciers or Poissiers," with illustrations of glacier movements, by the aid of lantern slides. He said that pitch and glacier ice strikingly resemble each other in behaving as solids or liquids according to their manner of treatment. On the sudden application of force they are very brittle, but behave as fluids when subjected to gradual pull and pressure. Hence it is possible to employ pitch in the construction of working models of glaciers, in order to get an insight into those internal movements of actual glaciers which are beyond the reach of direct observation. The study of glacial deposits has shown that many erratic boulders were transported during the glacial period from lower to higher levels hundreds of feet, and left stranded on the flanks of mountains. This standing difficulty in the way of physical theories of glacier movement has been explained by the study of pitch models, by means of which it is found that the lower layers of material, in approaching an obstacle, are carried up in an ascending current. The inference, which is confirmed by natural facts, is that similar movements would certainly take place in actual glaciers. Further, a glacier sometimes over-rides its terminal without disturbing it; and in one experiment this was exemplified, for pitch flowed for several months over a ridge of loose material, without carrying a particle of it away.—*The Colliery Guardian.*

The New York, New Haven & Hartford Railroad Company, New Haven, Conn., have recently added two more automatic railways of the Hunt type (C. W. Hunt Company, New York City, manufacturers) to their already complete system.

Mr. F. C. VanDuzen, late superintendent of the Stewart Iron Co's. plant at Uniontown, Pa., has been appointed general manager of the Crozer Coal and Coke Co., at Elkhorn, West Va..

MISCELLANEOUS.

THE SUN'S HEAT.

The Persian recognizes in the sun, not only the great source of light and warmth, but even of life itself and the advances of modern science ever tend to bring before us with more and more significance the surpassing glory with which Milton tells us the sun is crowned, and the prodigality with which it pours forth its radiant treasures.

An intelligent gardener once reasoned that the sun could not be a hot glowing body. He said:

"If the sun were a source of heat, then the closer you approach the sun the warmer you would find yourself. But this is not the case, for when you are climbing up a mountain you are approaching nearer to the sun all the time, but, as everybody knows, instead of feeling hotter and hotter as you ascend, you are becoming steadily colder and colder. In fact, when you reach a certain height, you will find yourself surrounded by perpetual ice and snow, and you may not improbably be frozen to death when you have got as near to the sun as you can; therefore, it is all nonsense to tell me the sun is a scorching hot fire."

I asked him wherein lies the advantage of putting his tender plants into his greenhouse in November. How does that preserve them through the winter? How is it that even without artificial heat the mere shelter of the glass will often protect plants from frost? I explained to him that the glass acts as a veritable trap for the sunbeams; it lets them pass in, but it will not let them escape. The temperature within the greenhouse is consequently raised, and thus the necessary warmth is maintained. The dwellers on this earth live in what is equivalent, in this respect, to a greenhouse. There is a copious atmosphere above our heads, and that atmosphere extends to us the same protection which the glass does to the plants in the greenhouse. The air lets the sunbeams through to the earth's surface and then keeps their heat down here to make us comfortable. When you climb to the top of a high mountain you pass through a large part of the air. This is the reason why you feel warmer on the surface of the earth than you do on the top of a high mountain. If, however, it were possible to go very much closer to the sun; if, for example, the earth were to approach within half its present distance, it is certain that the heat would be so intense that all life would be immediately scorched away.

The earth on which we stand is no doubt a mighty globe, measuring as it does 8,000 miles in diameter; yet if the earth be represented by a grain of mustard seed, then on the same scale the sun should be represented by a coconut. Perhaps, however, a more impressive conception of the dimensions of the great orb of day may be obtained in this way. Think of the moon, the queen of the night, which circles monthly around our heavens, pursuing, as she does, a majestic track at a distance of 240,000 miles from the earth. Yet the sun is so vast that if it were a hollow ball, and if the earth were placed at the centre of that ball, the moon could revolve in the orbit which it now follows, and still be entirely enclosed within the sun's interior.

For every acre on the surface of our globe there are more than 10,000 acres on the surface of the great luminary. Every portion of this illimitable desert of flame is pouring forth torrents of heat. It has indeed been estimated that if the heat which is incessantly flowing through any single square foot of the sun's exterior could be applied under the boilers of an Atlantic liner, it would produce steam enough for an entire record breaking voyage from Ireland to America. It would seem very presumptuous for us to assume that the great sun has come into existence solely for the benefit of poor humanity. The heat and light daily lavished by that orb of incomparable splendor would suffice to warm and illuminate, quite as efficiently as the earth is warmed and lighted, more than two thousand million globes each as large as the earth.

What should we think of the prudence of a man who, having been endowed with a splendid fortune of not less than $20,000,000, spent one cent of that vast sum usefully and dissipated every other cent and every other dollar of his gigantic wealth in mere aimless extravagance? This would, however, appear to be the way in which the sun manages its affairs, if we are to suppose that all the solar heat is wasted save that minute fraction which is received by the earth. Out of every twenty million dollars' worth of heat issuing from the glorious orb of day, we on this earth barely secure the value of one single cent, and all but that insignificant trifle seems to be utterly squandered. We may say it certainly is squandered so far as humanity is concerned. No doubt there are certain other planets besides the earth and they will receive quantities of heat to the extent of a few cents more. It must, however, be said that the stupendous volume of solar radiation passes off substantially untaxed into space, and what may there become of it science is unable to tell.

And now for the great question as to how the supply of heat is sustained so as to permit the orb of day to continue in its career of such unparalleled prodigality. Every child knows that the fire on the domestic hearth will go out unless the necessary supplies of wood or coal can be duly provided. The workman knows that the devouring blast furnace requires to be stoked incessantly with fresh fuel. How, then, comes it that a furnace, so much more stupendous than any terrestrial furnace, can continue to pour forth in perennial abundance its amazing stores of heat without being nourished by continual supplies of some kind? Prof. Langley, who has done so much to extend our knowledge of the great orb of heaven, has suggested a method of illustrating the quantity of fuel which would be required, if indeed it were by successive additions of fuel that the sun's heat had to be sustained.

Suppose that we extracted from the earth every ton of coal it possesses in every island and in every continent, and that this vast store of fuel, which is adequate to supply the wants of this earth for centuries, were to be accumulated in one stupendous pile and that an army of stokers were employed to throw this coal into the great solar furnace. How long, think you, would so gigantic a mass of fuel maintain the sun's expenditure at its present rate? I am but uttering a deliberate scientific fact when I say that a conflagration which destroyed every particle of coal contained in this earth would not generate so much heat as the sun lavishes abroad to ungrateful space in the tenth part of every single second. During the few minutes that the reader has been occupied over these lines a quantity of heat which is many thousands of times as great as the heat which could be produced by the ignition of all the coal in every coal pit in the globe has been dispersed and totally lost to the sun.

As the sun shines to-day on the earth, so it shone yesterday; so it shone in the earliest dawn of history; so it shone during those still remoter periods when great animals flourished which have now vanished forever, and during that remarkable period in earth's history when the great coal forests flourished; so it shone in those remote ages many millions of years ago when life began to dawn on an earth which was still young. There is every reason to believe that throughout these illimitable periods which the imagination strives in vain to realize, the sun has dispensed its radiant treasures of light and warmth with just the same prodigality as that which now characterizes it.

We all know the consequences of wanton extravagance; and the expenditure of heat by the sun is the most magnificent extravagance of which human knowledge gives us any conception. How have the consequences of such awful prodigality been hitherto averted? How is it that the sun is still able to draw on its heat reserves from century to century, ever squandering two thousand million times as much heat as that which genially warms our temperate regions, and draws forth the exuberant vegetation of the tropics, or which rages in the Desert of Sahara? This is indeed a problem.

It was Helmholtz who discovered that the continual maintenance of the sun's temperature is due to the fact that the sun is neither solid nor liquid, but is to a great extent gaseous. His theory of the subject has gained universal acceptance. Nature has not one law for the rich and another for the poor. The sun is shedding forth heat, and therefore, affirms this law, the sun must be shrinking in size. We have learned the rate at which this contraction proceeds, for among the many triumphs which mathematicians have accomplished must be reckoned that of having putting a pair of callipers on the sun so as to measure its diameter. We thus find that the width of the great luminary is ten inches smaller to-day than it was yesterday. Year in and year out the glorious orb of heaven is steadily diminishing at the same rate. For hundreds of years, aye, for hundreds of thousands of years, this incessant shrinking has gone on at about the same rate as it goes on at present. For hundreds of years, aye, for hundreds of thousands of years, the shrinking still will go on. As a sponge exudes moisture by continuous squeezing, so the sun pours forth heat by continuous shrinking. So long as the sun remains practically gaseous so long will the great luminary continue to shrink, and thus continue its gracious beneficence. Hence it is that, for incalculable ages yet to come, the sun will pour forth its unspeakable benefits; and thence it is that for a period, compared with which the time of man upon this earth is but a day, summer and winter, heat and cold, seedtime and harvest, in their due succession, will never be wanting to this earth.—*Condensed from Article by Sir Robert Ball in N. Y. Sun.*

THE WORLD'S TALLEST STRUCTURES.

The tallest chimney was built at Port Dundas, Glasgow, Scotland, 1857 to 1859, for F. Townsend. It is the highest chimney in the world (454 feet), and one of the loftiest masonry structures in existence. It is, independent of its size, one of the best specimens of substantial, well made brick work in existence. In Europe there are only two church steeples that exceed this structure in height—namely, that of the Cologne Cathedral (510 feet) and that of the Strasburg Cathedral (468 feet). The great Pyramid of Tizeh was originally 480 feet, although not so high at present. The United States outtops them all with its Washington Monument, 550 feet high, and the tower of the Philadelphia Public Buildings, which is 537 feet high.

The Eiffel Tower, at Paris, France, surpasses all other terrestrial metal structures with its altitude of nearly one thousand feet. The "Great Tower," for London, England, in course of construction from designs of Mr. Henry Davey, C. E., will outtop all metal structures, being built of steel, and its extreme height will be 1,250 feet when finished.

The highest and most remarkable metal chimney in the world is erected at the imperial foundry at Halsbrucke, near Freiberg in Saxony. The height of this structure is 452.6 feet, and 15.74 feet in internal diameter, and is situated on the right bank of the Mulde, at an elevation of 219 feet above that of the foundry works, so that its total height above the sea is no less than 711.75 feet. The works are situated on the left bank of the river, and the furnace gases are conveyed across the river to the chimney on a bridge through a pipe 3,227½ feet in length.

The highest artifical structure in America is the water works tower at Eden Park, Cincinnati, O. The floor of the tower, reached by elevators, is 522 feet above the Ohio River. The base is 404 feet above the stream. If the height of the elevator shaft be added to the observation floor the grand total height is 589 feet.

The highest office building in the world is the Manhattan Life Insurance Company of New York city; its height above the sidewalk is 347 feet, and its foundations go down 53 feet below the same, being 20 feet below tidewater level, making a total of 400 feet. The foundations consist of fifteen masonry piers, and are carried by the same number of steel caissons. The latter were sunk to bedrock by the pneumatic process. The cantilever system was used for the foundation. —*From Machinery.*

WHAT ALL BOYS SHOULD KNOW.

Don't be satisfied with your boy's education or allow him to handle a Latin or Greek book until you are sure that he can—

Write a good legible hand.
Spell all the words he knows how to use.
Speak and write good English.
Write a good social letter.
Add a column of figures rapidly.
Make out an ordinary account.
Deduct 16½ per cent. from the face of it.
Receipt it when paid.
Write an ordinary receipt.
Write an advertisement for the local paper.
Write an ordinary promissory note.
Reckon the interest or discount on it for days, months or years.
Draw an ordinary bank check.
Take it to the proper place in a bank to get the cash.
Make neat and correct entries in day-book and ledger.
Tell the number of yards of carpet required for your parlor.
Measure a pile of lumber in your shed.
Tell the number of bushels of wheat in your largest bin, and the value at current rates.
Tell something about the great authors and statesman of the present day.

If he can do all this, and more, it is likely he has sufficient education to make his own way in the world. If you have more time and money to spend upon him all well and good—give him higher English, give him literature, give him mathematics, give him science, and if he is very anxious about it, give him Latin and Greek, or whatever the course he intends pursuing in life demands.—*School Supplement.*

BENEATH THE FINGER NAILS.

There is something more than beauty and attractiveness to be considered in caring for the finger nails. Beneath them is a space which forms a nidus or resting-place for bacteria. Bacteriologists have found a score or more of different kinds of organisms under the nails, many of them harmless, it is true, but some of them exceedingly dangerous to health and life. Since they are microscopic in size, no one can tell whether they are innocent or harmful, or, indeed, whether they are present or absent.

Since a pin prick suffices to convey into the human system enough of the most poisonous germs of disease to cause death, it is easy to understand what evil results may follow a scratch with a germ-laden finger nail. An idea has gone abroad that the danger lies in being scratched by another person; but since the trouble is due to bacteria and not to any poison residing in the nail itself, it is easy to see that a self-inflicted scratch may be as bad as any other.

Many instances are recorded where a slight wound, like the prick of a needle under the nail, has been the means of introducing the germs which cause that painful trouble known as whitlow or felon.

He who bites the finger nails takes the risk of getting into his mouth and swallowing the germs of some infectious disease; for bacteria may be anywhere and the nails have a peculiar aptitude for scraping up particles of dust and dirt, which may be swarming with germs. The surgeon who goes to the performance of any cutting operation, realizing the danger which lurks beneath the nails, cleanses them in the most thorough manner.

Disease germs, once introduced into the human organism, become travellers. They do not stop at the point of infection, but once in the circulation, may go anywhere and live, even for years, waiting their opportunity for growth when the normal tone of the system is lowered by chill, by fatigue, or some other disturbing cause.

There is no better method of cleansing the nails than with a good brush and plenty of soap and water, and without the use of a brush it is impossible to have clean, wholesome nails. Not alone will the result obtained be pleasing to the eye, but the danger of becoming the bearer of disease to one's self is thereby lessened.—*Youth's Companion.*

SENSATIONS EXPERIENCED IN FALLING.

Dr. Heim, the celebrated geologist and professor of the Zurich University, declares that sudden death by a fall, by being run over, or by being swallowed up by machinery, water or by snow avalanche is the most beautiful way of leaving this life— is indeed preferable to any other mode or fashion of departure for the unknown regions.

He gives the following description of his journey down a mountain side, which, as he fully expected, would end in certain death:

"I was coming with two friends from the summit of the Santis in St. Gallen, when, at the height of 5,400 feet, we found ourselves opposite a snow field lying between two mighty rocks that had to be traversed. It was a perilous path, running apeak for several miles, it seemed. My companions hesitated to take it, but I decided to slide down on both feet, standing up boldly. I went down with unequalled velocity, but there was no danger until I made a movement to save my hat, which the current of air was carrying along. I fell and lost all control of my limbs.

"Quick as the wind I flew against the rocks to my left, rebounded, and was thrown upon my back, head downward. Suddenly I felt myself carried through the air for at least 100 feet, to finally land against a high snow wall. At the instant I fell it became evident to me that I was to be thrown against the rock, and I did my utmost to avert that calamity by digging with my fingers in the snow and tearing the tips of them horribly without knowing it. I heard distinctly the dull noise produced when my head and back struck against the different corners of the rock; I also heard the sound it gave when my body bounded against the snow wall, but in all this I felt no pain; pain only manifested itself at the end of an hour or so.

"I reckoned that my descent down the mountain side lasted five or six seconds. It would take me two hours to describe the thoughts and feelings I underwent during this short space of time. And all my thoughts, notions and ideas were thoroughly consistent and coherent, not mixed up and jumbled up as in dreams. First, as already intimated, I saw the possibility of my fate. I calculated to myself: Ten to one I will be a dead man upon my arrival at the bottom of the mountain. If, however, I find myself alive and fully conscious I will have to take some of the vinegar-ether, which, on leaving the Santis, I placed in my vest pocket. A good thing, I mused to myself, that it is where it is. I would scarcely be able to reach for it if it was still in my knapsack, where I used to carry it. I will take two or three drops of the ether on my tongue, I continued in my thoughts. That will revive me and keep me from taking cold. But what about my stick? Ah, that may be useful if I live, and besides, it is a beautiful Alpenstock. I will keep it. And, true enough, I held on to it. Then I thought that it might be well to take off and throw away my spectacles, that they might break and injure my eyes, I reached for them, but was unable to do as intended.

"Thus I spent several or maybe only one precious second in egotistical circumspection. After that my thoughts turned upon the consequences which my death would have for my family. I must try to save myself for the sake of my wife and children, I argued. The friends that were with me are probably lamed by terror, and I must double their energies by calling for help, if I can. A good way to spur them, I thought, would be to cry out, 'I am all safe, but must have a drink at once.' Then I managed to be present when the news of my death reached home. I heard my wife and children cry and lament, and I tried to condole with them. I even cracked jokes in this endeavor. Again I saw with my mind's eye the confusion that would reign in the university on account of my failure to begin lecturing. That brought back to me all my struggles, my early training, my trials and small triumphs. My life, from childhood to manhood, glided past my mental observation like a living picture, vivid, impressive, joyful and sorrowful, as it had been. Tableau followed tableau in quick succession, each figure being distinct, and incidents being perfectly and completely pictured. When I had arrived at my present state and condition I saw a magnificent blue heaven opening to receive me. All was serene happiness, while rosy and violet clouds marked the horizon. Into this heaven I floated with perfect equipoise, with beautiful anticipation, while my mundane eyes perceived my body flying through the air, and saw the snow field below. I heard a dull thud; I had struck the ground.

"It is an open question to me whether the above described sensation of going to heaven is not a very strong argument for the teachings of the Christian religion. The mind of man becomes clear and pure on the threshold of eternity; it becomes the most wonderful machinery for thought and observation. Its retrospective facilities are marvelous. Can its prognostics be waved aside?

"After finishing off all earthly affairs and making peace with man, the independent soul sees the heavens open; all around is beauty and happiness—a world steeped in blue and roseate tints. I should say here that I am far from being a pronounced religious man. At no period of my life have I been given to speculating much on the teachings of the Church, but when about to die I experienced all those sensations which are ascribed to deeply devout persons during their last moments on earth.

"To return to actualities, I will repeat that during my downward journey time seemed to stretch indefinitely, and the faculties of objective observation, subjective feeling and thinking worked simultaneously without interfering with each other. There was no confusion, no perplexity; my calculations were logical; I acted with lightning rapidity.

"I thought to do so, too, when I began to cry out, as intended, 'I am safe, bring me water,' or words to that effect, but I had actually lain perfectly still, without the least mental or physical performance, for over half an hour before I gave that sign of returning life. My friends who had watched me from above and afterward sat at my side for a considerable time say so. Without seeing them I took the vinegar bottle from my vest pocket, reached for my spectacles that rested at my side, and felt of my back and limbs to find out if any bones were broken. The fact that I failed to notice my friends, and did not even look at them, is explainable only on the theory that I continued thinking where I had left off my selfish calculations when unconsciousness overcame me; it was instinct of self-preservation that dominated my feelings upon regaining life. Forty minutes I had been dead to the world and to myself, and at the termination of this period I was the same selfish being as before. I cried for help, because, having no recollection of the comatose state in which I had been, I thought my friends at least a mile or two away, as they were at the time I reached the foot of the mountain."

And did the heavenly thoughts re-occur to you, also? the professor was asked.

"No," said Dr. Heim. "I experienced them only at the moment of standing on the threshold of eternity. Then my soul rose gloriously to the occasion, but the certainty of death being removed, my material instincts and spirits triumphed." —*The Inter-Ocean.*

HOW MACCARONI IS MADE.

Maccaroni is divided into thirteen classes, though each is the product of the same batch of flour and the same kneading, but vary they in size, shape and general appearance. Among Italian gourmets they are known as mezzani, forati, frenetti, trenetini, foralini, spaghetti, spaghettin, rigatoni, seme di melloni, rosa marina, stellini, tubetini and acine di fippi. The visitor to a factory is confronted by a big iron lathe arrangement with a cylinder the size of an ordinary snare drum at the business end. Through the center of this lathe slowly revolves a powerful screw.

Flanking the entrance are stands shoulder high, upon which rest strings of "maccaroni," strung over bamboo rods. The mixing trough is a box 6x4 feet. It has a depth of one foot. Here is where the first steps are taken.

With a regularity born of long practice flour is gradually mixed beneath the water faucets and kneaded by hand until it reaches a consistency and toughness that human strength cannot overcome. Then the batch, which is the size of a wash tub, is carried over to the "final kneader." This kneader is a curiosity. There is a solid block with protected sides, and into this the batch of dough is deposited. Hinged to the block, but getting a "spring" from a rope passed over a hickory stick braced to the wall, is a 14-foot "joist" of hard wood. For five feet of its length this joist is cut wedge shape. This wedge exactly covers the block upon which the "batch" rests. The remainder of the joint is squared and furnishes a seat for the "kneaders."

All being in readiness, the joist is swung to one end of the batch, and two or three men plant themselves on the square end. Then follows a performance that resembles the old-fashioned see-saw. Quickly, but with never failing regularity, the kneaders rise and fall on the joist, but each time push it in a circle a few inches. This is kept up until the "chief" is satisfied with the consistency of the mass. Without the loss of a minute the bare-legged and bare-chested kneaders carry the batch to the iron drum at the end of the lathe. In it goes with a rush. The "engineer" slips an iron disk that just fits the cylinder against the mass, and by the pressing of a button starts the electric dynamo.

Slowly the long screw revolves until its head is firmly against the disk. Then the mass is forced against the lower end of the drum, with irristible pressure.

This lower end is perforated at regular intervals with round openings the size desired, and from these openings come a miniature Niagara of sinuous dough. As the white stream reaches the accepted length it is broken off by a dexterous twist and doubled over a bamboo rod.

As quick as possible the rod with its 50 pounds of maccaroni is taken down into the cellar and put on the rack. There it remains about four days, or until thoroughly hardened. Then comes the packing and shipping.—*Boston Globe.*

SOME CURIOUS FACTS CONCERNING HEARING.

An inquiry was recently made in London as to the greatest distance at which a man's voice could be heard, leaving, of course, the telephone out of consideration. The reply was most interesting and was as follows: "Eighteen miles is the longest distance on record at which a man's voice has been heard. This occurred in the Grand Canon of the Colorado, where one man shouting the name 'Bob' at one end his voice was plainly heard at the other end, which is eighteen miles away. Lieutenant Foster, on Parry's third artic expedition, found that he could converse with a man across the harbor of Port Bowen, a distance of 6,696 feet, or about one mile and a quarter; and Sir John Franklin said that he conversed with ease at a distance of more than a mile. Dr. Young records that at Gibraltar the human voice has been heard at a distance of ten miles."

Sound has remarkable force in water. Colladon, by experiments made in the Lake of Geneva, estimated that a bell submerged in the sea might be heard a distance of more than sixty miles. Franklin says that he heard the striking together of two stones in the water half a mile away. Over water or a surface of ice sound is propagated with great clearness and strength. Dr. Hutton relates that on a quiet part of the Thames near Chelsea he could hear a person read distinctly at a distance of 140 feet, while on the land the same could only be heard at 76 feet. Professor Tyndall, when on Mont Blanc, found the report of a pistol shot no louder than the pop of a champagne bottle. Persons in a balloon can hear voices from the earth a long time after they themselves are inaudible to people below.—*From Harper's Round Table.*

NOVEL PROTECTION AGAINST FIRE.

A merchant of Gowanda has invented a most remarkable apparatus for saving stocks of goods from fire. Instead of of putting out the fire the apparatus opens the front of the store, and the counters, cases, and shelving roll out into the streets into their owner's arms.

The shelving and counters in the store are all portable, and mounted on rollers. Attached to the rear end of the shelving is a cable which runs forward and over a wheel below the floor in the front of the store. To this end of the cable are suspended weights sufficiently heavy to overbalance the shelving, cases, and goods in them. A break device keeps the weights from setting the machine going. Attached to the lever of the brake is a combustible cord which passes upward into the store and is carried along the walls and ceiling, where it will be quickly ignited in case of fire. The sundering of the cord looses the brake, the weights bear on the cable, and the shelves start helter skelter for the front of the building. At the same time the windows and doors open automatically outward, and the entire contents of the store are dumped on the sidewalk in a jiffy. To frustrate the designs of fire thieves the shelves fold up when they reach the street, presenting only blank wood and glass.

Those who have seen the apparatus tested say that it works admirably. One night a mouse found something palatable in the brake cord and gnawed it in two, whereupon, much to its consternation, the furniture, boxes, and shelves with one accord began a swift movement forward, and an automatic alarm attached to the machine began to rouse all the the inhabitants of Gowanda, the hour being 2 o'clock in the morning. The ingenious inventor was one of the first on the scene, and his disgust at being routed out by a false alarm was greatly mitigated by the spectacle of the smooth working of his machine. It seems to be a good thing, and pushes itself along with no help.—*From the Buffalo Courier.*

A BEDROOM "WIND-CURTAIN."

To get plenty of air into a sleeping room at night without the cold or damp wind blowing directly upon the bed is necessary alike for comfort and health.

The familiar device of a board fitted to set tightly into the window-frame underneath the raised lower sash answers for extremely cold nights; but it does not give enough air in moderate weather. On the other hand, if a severe wind is blowing upon the opened window, although the temperature may not be very low, the strong current is too trying for most sleepers.

To those who wish to enjoy the open window at night, and yet to be defended against a direct current of air, the wind-curtain will be valuable.

About a foot above the window-stool, on both edges of the casings, insert diagonally a pair of two-inch screw hooks. Being on the outside edges of the casings, they do not mar the wood, and are unnoticed during the day. Prepare a light curtain-pole, say an inch in diameter, and insert screw-eyes to correspond with the hooks. The pole may be a regular curtain-pole with brass knobs, or a bamboo pole, or a humble broomstick—painted, however, we will hope.

Hang upon this pole, either by rings, or by a broad hem through which the pole is thrust, a short curtain of burlap. This coarse cloth is suggested because of its very openness; while breaking the force of the wind, it admits much of it in a gentle way. This may be trimmed tastily with a half-inch hempen rope, or with cat stitching.

To prevent the curtain from flapping in the wind, sew to it a pair of small rings, which can be loosely attached to another pair of small hooks screwed on the under side of the window-stool at its extremities.

The chief admission of air will not be through the interstices of the coarse burlap, but above and around it, from the three or four-inch space between it and the sash. A shawl or an afghan may be thrown over the pole instead of a regularly hung curtain, and will answer the purpose equally well. In the morning the pole is lifted from its inconspicuous hooks, and stored away in the closet out of sight.

If it is preferred to have the window opened at the top, the same contrivance may be used—the window-shade being run up out of the way, and thus preserved from flapping or from damage by rain.—*Youth's Companion.*

SOMETHING ABOUT FIRE ENGINES.

What is, perhaps, the oldest known fire-engine for pumping water, is mentioned in the Spiritalia of Hero, about 150 B. C. This engine had two single acting pumps, the plungers of which were worked by a single beam pivoted between the two. The streams united in a single discharge pipe, passing up a trunk in which was an air chamber, and out at a nozzle which could be turned in any direction. This description might stand for a great many forms of hand fire-engines used even to the present day. The early Romans appear to have paid quite some attention to fire extinguishing apparatus, and had an organized fire brigade.

Something like the more modern fire engine appears to have been brought out in the early part of the sixteenth century; and is described as a "water syringe." This was mounted on wheels, and was worked by levers. Fire engines of this kind were apparently much used in Germany. In England, during the latter part of the sixteenth century, large brass syringes were employed, holding several quarts of water, and operated by three men, two holding the syringe at each side with one hand and directing the nozzle with the other, and the third operating the plunger. After having discharged the water, the syringe was refilled from a cistern or well near the fire, or from buckets. Later, these water squirts were fitted to portable cisterns or tanks.

In the latter part of the seventeenth century a portable engine, mounted on a cistern or tank, from which the water was drawn, was introduced in England by Newsham. This engine was, in many respects, similar to the modern hand fire engine, and continued in use in England up to 1832.

The Newsham engine was, perhaps, the first successful fire engine, and really was the pioneer of the modern, manually operated engine. The pumps were of various sizes and designs, and were, in most cases, operated by levers. Various forms of engines, similar to the Newsham engine, continued in use as late as 1850.—*Joseph Sachs in Cassier's Magazine.*

THE EVILS OF OVER-EATING.

I assert that it is the duty of the good housewife to keep down the appetite of her husband. Particularly is this necessary in the cases of well-to-do professional and business men. In the families of mechanics earning low wages such a warning is almost wholly unnecessary, but it may be said of most men in good circumstances that they eat too freely of rich food. If men would begin careful and systematic physical culture in early youth and continue the practice through life, good health would be the result. Beyond the age of forty—at a period when so many are physically lazy—the superior value of exercise is apparent; but ordinarily, this is just the time when the hygiene of athletics is neglected. There is no reason why a punching-bag, rowing-machine, pulley-weights and other apparatus should be relegated to college boys and clerks. But having done a good deal of work in his time it is almost impossible to persuade a business or professional man, turning forty, to give any sort of attention to physical culture if such training has been previously neglected. Hence, I say it is the duty of a woman to keep from her husband all rich compounds that will ultimately ruin his digestion. High feeding is occasionally neutralized by hard exercise; but in the absence of the latter it is mischievous in the extreme. If your husband will stand the treatment, begin by switching off from the heavy breakfast of steak, hot rolls, potatoes, etc. and set before him eggs-on-toast, oatmeal and coffee.—*Rev. F. S. Root, in Ladies' Home Journal.*

FLORIDA'S ALLIGATOR FARMS.

The attention of the United States Fish Commission has been called recently to a new and remarkable industry, namely, the artificial propagation of alligators. For supplying the trade in Florida curiosities there is a large demand for young reptiles of this kind. In Jacksonville, which is the centre of the traffic, from 8,000 to 10,000 alligators are sold to tourists annually—nearly all of them baby ones. The latter are collected in considerable numbers by professional hunters, who receive for them from $20 to $25 a hundred. Some of them are disposed of alive at retail, but many are stuffed. An infant alligator stuffed is worth twenty-five cents more than a live one. Saurians six to twelve feet long fetch $12 to $25.

The difficulty of securing young alligators in sufficient numbers has led to the establishment of the strange business described. To find the nests of these reptiles is comparatively easy, and the eggs are shipped in bulk by the hunters to Jacksonville. In that city there are twelve dealers in alligators, the best known of them being a man who has earned the sobriquet of "Alligator Davis." It was he who originated the incubator system, which is simple enough. The eggs, about the size of goose eggs, are placed in boxes of sand and covered up. The boxes are exposed on a roof to the torrid rays of a semi-tropical sun, and in a few days the lizards are hatched. They are six inches or so in length when they make their first appearance in the world. Some of them are killed and stuffed as soon as they see daylight.

A species of true crocodile is found in southern Florida on both coasts. It is hardly distinguishable from the alligator except by the shape of its head, though it grows bigger, attaining a length of eighteen feet. Dr. Hugh M. Smith of the Fish Commission says that young crocodiles are hatched for market in the same fashion. The mother crocodile lays her eggs in sand like a turtle, and simply covers them over. Somewhat different is the practice of the maternal alligator, who, in April or May, seeks a sheltered spot on a bank and there builds a small mound. The foundation of the mound is of mud and grass, and on this she lays some eggs. She covers the eggs with another stratum of grass and mud, upon which she deposits some more eggs. Thus she proceeds until she has laid from 100 to 200 eggs.

The eggs, in course of time, are hatched by the sun, assisted by the heat which the decomposition of the vegetable material generates. As soon as they have "chipped the shell" the baby alligators are led to the water by the mother, who provides them with food which she disgorges, showing much anxiety for their safety. At this early period of their existence they are exposed to many dangers, being a favorite prey of fishes and turtles. Alligators' eggs, by the way, are sometimes eaten by the Florida Crackers. The robbing of the nests for market is helping to hasten the inevitable destruction of the alligator fishery, which has been an important and profitable industry in Florida. Facts recently gathered by the Fish Commission show that the reptiles cannot long escape practical extermination. Already they are becoming scarce, and the price of hides has gone up.

It is estimated that 2,500,000 alligators were killed in Florida between 1880 and 1894. In 1889 three firms, located at Kissimmee for the purpose of buying skins taken in the region between Lake Kissimmee and Lake Okeechobee, handled 30,000 hides. During the same year twelve hunters brought to Fort Pierce 4,000 pelts. Two firms in Jacksonville handled 30,000 skins in 1889. A few years ago an expert hunter could easily secure 600 alligators in three weeks, and one man at Cocoa killed forty-two in one night. The skins are paid for in provisions and ammunition mainly. Dealers get sixty-five cents apiece for them from tanners in New York.

In 1890 about 250 pounds of alligator teeth were sold, hunters receiving from $1 to $2 a pound for them. They are removed by burying the head and rotting out the teeth. Of the best teeth about seventy make a pound. The stuffing of alligators and the polishing of the teeth give employment to forty persons. Unfortunately, alligators grow very slowly. At 15 years of age they are only two feet long. A twelve-footer may be supposed reasonably to be 75 years old. It is believed they grow as long as they live, and probably they live longer than any other animals.—*From the Washington Evening Star.*

EDUCATING POWER OF DANGER.

A writer on high mountaineering thus praises the good effects of danger in this pursuit:

"There is an educative and purifying power in danger that is to be found in no other school, and it is worth much for a man to know that he is not 'clean gone to flesh pots and effeminacy.' It may be admitted that the mountains occasionally push things a trifle too far. But grim and hopeless as the cliffs may sometimes look when ebbing twilight is chased by shrieking wind and snow and the furies are in mad hunt along the ridges, there is ever the feeling that brave companions and a constant spirit will cut the gathering web of peril.

"Something may surely be urged in favor of a sport that teaches, as no other teaches, endurance and mutual trust, and forces men occasionally to look death in its grimmest aspect frankly and squarely in the face. Amongst the mountains, as elsewhere, 'the unexpected always happens.' It is the momentary carelessness in easy places, the lapsed attention or the wandering look that is the usual parent of disaster."

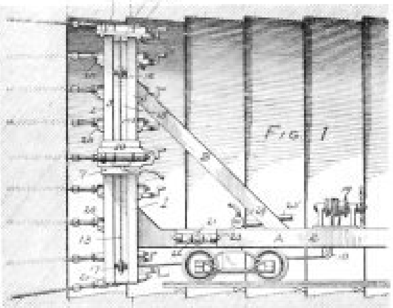
These words are worth remembering. There seems to be something enchanting in danger, and especially is this so to boys. What man now in mature life does not remember the dangers to which, as a boy, he has voluntarily exposed himself, and, after all, parents may comfort themselves that there is less danger to life in these dangers than in being shut entirely away from them. Danger educates boys to be careful, and this is very important to their lives in later years.—*Journal of Hygiene.*

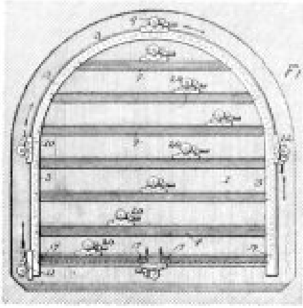
BIBLE MEASURES.

A day's journey was about twenty-three and one-fifth miles.
A Sabbath day's journey was about an English mile.
A cubit was nearly twenty-two inches.
A hand's breadth is equal to three and five-eighths inches,
A finger's breadth is equal to one inch.
A shekel of silver was about fifty cents.
A shekle of gold was $8.00.
A talent of silver was $538.30.
A talent of gold was $13,809.
A piece of silver, or a penny, was thirteen cents.
A farthing was three cents.
A mite was less than a quarter of a cent.
A gerah was one cent.
An ephah, or bath, contained seven gallons and five pints.
A firkin was about eight and seven-eighths gallons.
An omer was six pints.
A cab was three pints.—*Phila. Inquirer.*

TUNNELING APPARATUS.

No. 545,675. HARRY BRUNE, CHICAGO, ILL. *Patented Sept. 3rd*, 1895. Fig. 1 is a side view of the apparatus as it appears when at work in a heading; Fig. 2 is a rear view of the head frame. The method of driving a tunnel with this apparatus consists in cutting a channel groove around the sides and top of the heading, and blasting out the core thus left standing. The head frame 3, is shaped to suit the outline of the tunnel section, and it is tied together with a series of cross bars 4. It is supported upon a stout truck *A*, and is braced by bars *B*. The rim of the head frame has wide flanges, which are beveled on the edge to suit the saddles 7, of the channelling machines 9, 10, 11 and 12. These machines are connected to-

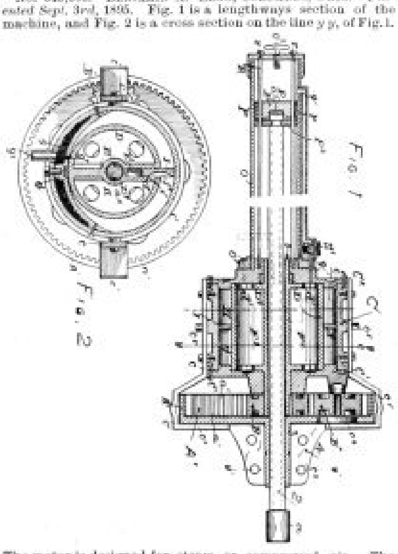




gether by means of a wire rope 13, which runs over suitable guide pulleys to a windlass 19. The whole set are thus fed laterally at the same time, by means of the windlass. The machines work at a sufficient angle to permit the drill cylinders to clear the standing edges of the preceding cuts, so that machines of ordinary make may be used. Shot holes are drilled in any number required, by drills 20, which are mounted on the cross bars 4. The air is received through the hose 25, into a manifold 24, from which a small hose leads to each machine. By closing the valve in 25 the entire machine is stopped. The machine is steadied when at work by side screw jacks 21.

MINE DRILL AND MOTOR.

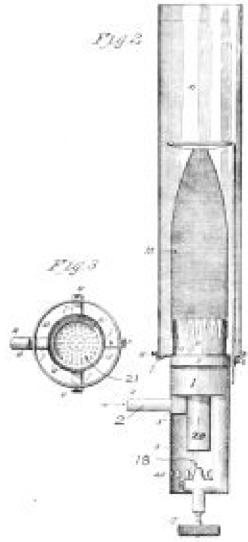
No. 545,596. BENJAMIN A. LEGG, COLUMBUS, OHIO. *Patented Sept. 3rd*, 1895. Fig. 1 is a lengthways section of the machine, and Fig. 2 is a cross section on the line *y y*, of Fig. 1.



The motor is designed for steam or compressed air. The drill spindle 2, is rotated by feathers in the hub 3, of the large gear *A'*, which is journalled in the bracket 4, and frame *C'*. The drill is fed up to its work by air or steam pressure acting upon the piston *P*, in the tube or cylinder *O*. The motor consists mainly of a barrel *D*, which revolves within the cylinder *C*. The chamber between them is divided by a partition *Y*. The barrel is turned by means of two pistons *J*, which slide back into suitable slots when passing the abutments *H* and *G*. The pistons are placed upon opposite sides of the barrel, so that when one is passing the abutment, the other is exerting full power. The steam or air is taken in through an annular groove in the cylinder head, and enters the barrel through the hole shown in its ends. When the piston *J*, is in good working position, a hollow *f'*, in its face, makes a communication from the interior of the barrel through the port *e'*, into the cylinder. The exhaust escapes at *g'*. The barrel has a projecting hub which carries a pinion *B*. Power is transmitted from this pinion to the wheel *A'*, by means of the idle wheel *B'*.

INCANDESCENT OIL LIGHT.

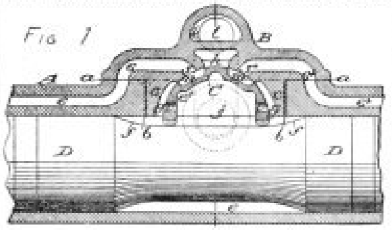
No. 545,398. CHARLES E. WHITE, KANSAS CITY, MO. *Patented Aug. 27th*, 1895. Fig. 2 is a side view partly in section; and Fig. 3 is a cross section near the top of the burner. Oil is supplied through the tube 2, to the chamber 1, which is maintained at a heat sufficient to vaporize it. The vapor escapes from the jet 18, and passes up the tube 20 accompanied by sufficient air to burn it. It is ignited above the burner cup 21, and burns with a thin pale flame which gives but little light, but which developes great heat. The burner

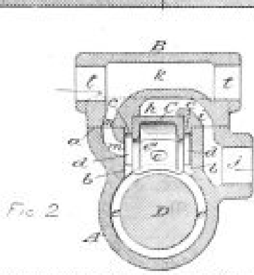


is enclosed by a cage or "mantle" 10, composed of a network of infusible threads. This is made by soaking a piece of coarse cloth of proper shape, in a solution of infusible earthy salts, and then destroying the cloth by incineration. The salts remaining form infusible threads. The heat of the burning gas causes the "mantle" to become highly incandescent, and to emit a strong white light. The light is free from all flickering, and the shadows cast by it are much softer than those from electric lights.

VALVE FOR ROCK DRILLS.

No. 545,738. HENRY C. SERGEANT, WESTFIELD, N. J. *Patented Sept. 3rd*, 1895. Fig. 1 is a section lengthways of the cylinder, and Fig. 2 is a cross section at the middle of the steam chest. The valve *C*, is circular in form and works on a concave seat. The valve comprises a little more than a half circle, and its ends are shaped to suit the shoulders *f*, of the drill piston *D*, which moves it at each end of the stroke. The steam or air is admitted to the annular chamber *c*, and passes

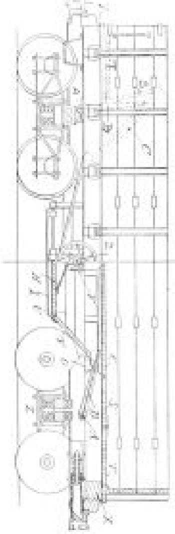




through the passages *g*, *g'*, to the ports 6, 6', according to the position of the valve. The exhaust passes out through the port *n*, and passage *i*, to the outlet *j*. Steam is received through either inlet *t*. By making the valve a full half circle, with its center at the outside of the bore of the cylinder, the working surfaces are brought nearly square to the direction of the pressure upon them, and the wear is greatly reduced, thus making the parts very durable.

ORE CAR.

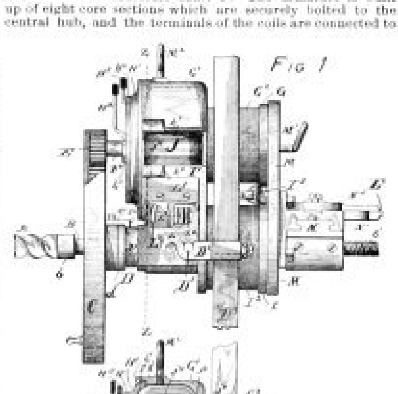
No. 542,831. DANIEL C. MULVIHILL, MARQUETTE, MICH. *Patented July 16th*, 1895. The drawing is a side view of the car, partly in section. The object of this invention is to provide a freight car for carrying ore or coal, having a suitable hopper bottom therefor; and which may be readily converted into a flat bottomed gondola, suitable for lumber or ordinary freight. The car frame has the usual side and middle sills, and two end sills. The middle cross sill *F*, is made of channel iron, having the flanges down. That part of the hopper which is below the frame is of ordinary construction. The sides *V* are permanent. The trap doors *H* are held up by chains, which are wound upon the shaft 2,

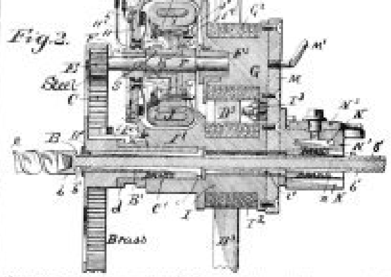


beneath the sill *F*. The end sections *T*, of the car floor are permanent. The hopper is covered by two lifting sections *C*, which are attached to the ends of the arms *B*. When it is desired to use the car for coal or ore, the arms *B* are raised by turning the rockshafts *A*, and the sections *C* are raised to the position shown by dotted lines at the left end of the car, thus forming an extension of the hopper. The lower edge of *C* then rests in pockets *O*, and the upper part is sustained by the sections *S*, which are turned up on edge for that purpose.

ELECTRIC MINE DRILL.

No. 545,570. HENRY H. BLISS, WASHINGTON, D. C. *Patented Sept. 3rd*, 1895. Fig. 1 is a side view of this machine, and Fig. 2 is a vertical section of the same. The drill spindle *B* is rotated by means of feathers *B'* in the hub of the main gear *C*. The feed motion is obtained by means of two half nuts *N*, which slide in a T groove in the bracket *N'*, and are closed or opened by means of a cam plate *N²*. The wheel *C* is of brass, and is driven by a steel pinion *E*, on the outer end of the armature shaft *F*. The armature is built up of eight core sections which are securely bolted to the central hub, and the terminals of the coils are connected to

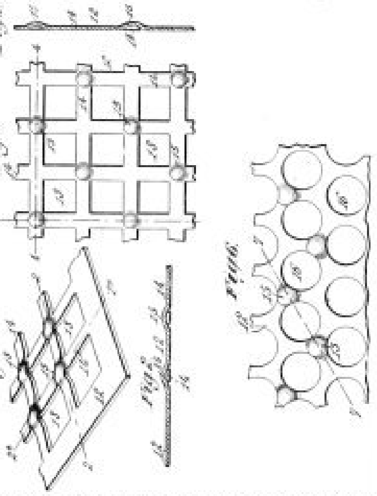




the commutator segments *S*, thus forming a "Gramme ring." The shaft is journaled in a brass block *F'*, which is sunk in the core *G* of the field magnet. The pole pieces *I'* and *G'* nearly enclose the armature, and the commutator is closed in and protected from dirt or injury by the plate *H*. The brushes *K* are attached to this plate, and means are provided for adjusting the pressure of the brushes from the outside and while running. The plate is turned to any desired extent by means of the handle H^1. By placing the armature out of center with the field magnet, the lower core J can be utilized to support the drill spindle, and the width of the machine, or the room required between the sides of the drilling post D^2, is reduced to a minimum.

SCREEN SEGMENT.

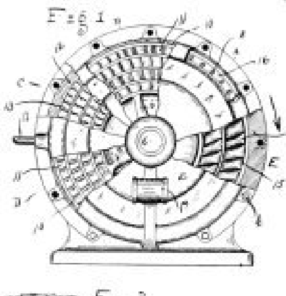
No. 543,780. John N. Pott, Chicago, Ill. *Patented July 30th, 1895.* Fig. 1 is a perspective view of a square meshed segment having this improvement; Fig. 2 is a section along the line 2; Fig. 3 is top view of another variety of mesh; Fig. 5 is a section through the same; and Fig. 6 is a top view of a round meshed segment. The object of this invention is to provide the working surface of a perforated-metal screen-plate with an effective arrangement of rounded protuberances, distributed at suitable intervals and located at intersections of the portions of metal left between the holes. By this construction there is provided an uneven screening-surface

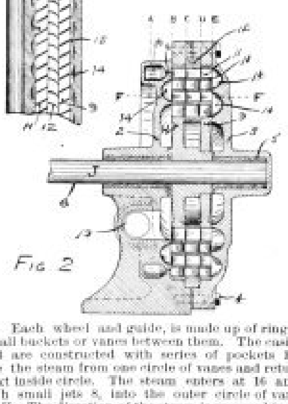


which will prevent the material being screened from passing over it in mass, and that will cause a slight undulatory movement in the said material, thereby assisting the smaller particles to descend to the surface of the screen, so that such as are small enough may readily pass through. The protuberances will also prevent the larger lumps of material from coming in contact with the sharp edges of the holes in the screen-plate, thereby avoiding considerable waste, as frail materials are liable to be broken by striking against such edges.

STEAM TURBINE.

No. 543,791. George C. Pyle, Indianapolis, Ind. *Patented July 30th, 1895.* Fig. 1 is a side view, having parts broken away to show various parts of the interior; Fig. 2 is a vertical cross section through the center; and Fig. 3 is a section on the line F. The two wheels H and 9 are similar in construction, and are keyed to the shaft J. Any number of wheels may be used. Between each pair of wheels there is a guide plate 12, having vanes which deflect the steam in a direction contrary to that in which it leaves the preceding

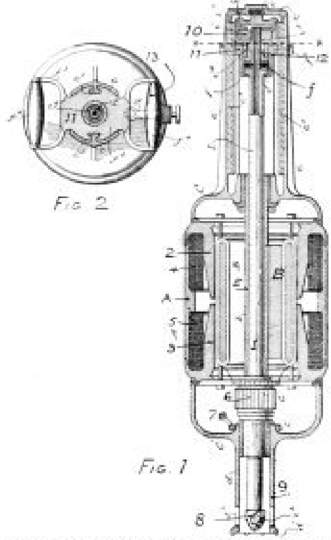




wheel. Each wheel and guide, is made up of rings 10, having small buckets or vanes between them. The casing plates 2 and 3 are constructed with series of pockets 14, which receive the steam from one circle of vanes and return it into the next inside circle. The steam enters at 16 and passes through small jets 8, into the outer circle of vanes in the wheel H. The direction of the steam is reversed in the guide plate 12, and it then passes through the outer circle of vanes 11 in wheel 9, and thence into the pockets 14, in casing 3. Here the steam is transferred to the next inner circle of vanes, and is then forced through the wheels to the opposite casing 2. It is thus forced through from side to side of the wheels, as often as desired, until it escapes into the central chamber, and into the exhaust 19. It is claimed that this construction utilizes a large and satisfactory percentage of the power of the steam.

ROCK DRILL.

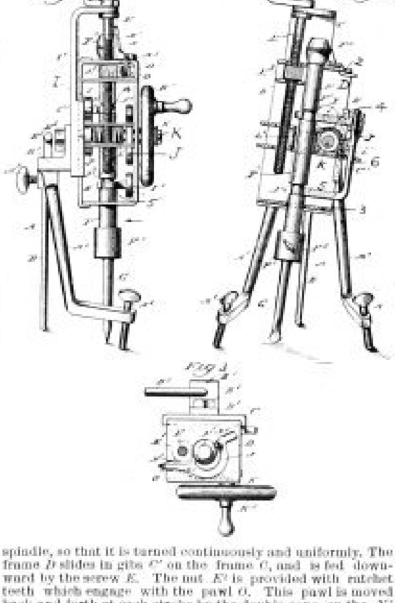
No. 545,109. Isle E. Storey, Boulder, Colorado. *Patented Aug. 27th, 1895.* Fig. 1 is a section lengthways of the machine; and Fig. 2 is a cross section at the line x, x. The movement of the drill is rotary, and it is propelled by electricity. The field magnet is composed of the cores 2 and 3, coils 4 and 5, and casing A. The armature B is secured to a



long sleeve E, which is journalled in the heads C and C'. The commutator 6, and brushes 7 are contained in the lower head. The drill spindle I is driven by means of a feather in the sleeve E. When it is drawn up to the limit of its stroke, the drill bit 8 comes inside of the foot piece 9, and is thus protected from accidental injury. Water is driven through the hollow drill spindle by means a rotary pump 10, which is built with the crosshead 11. The drill spindle is connected to the crosshead by a stuffing box 12 and a ball bearing f. To use the machine, it is stood up on the foot 9, the water hose is connected to the nozzle of the pump, and the electric wires are connected and the current turned on. The drill is pressed downwards by means of the handles 13 which are attached to the crosshead. A full sized drill weighs about 100 lbs., and may be operated by one man.

HAND ROCK DRILL.

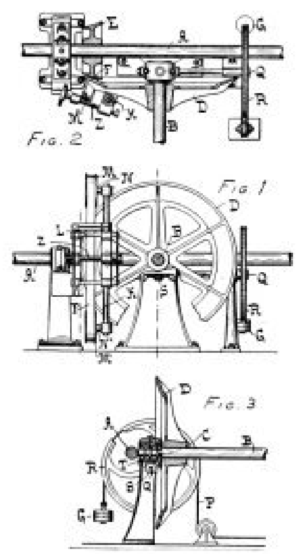
No. 545,335. Robert Binnie, Bolivar, Penna. *Patented Aug. 27th, 1895.* Fig. 1 is a front view; Fig. 2 is a side view partly in section; and Fig. 3 is a top view. The drill spindle F slides through the top and bottom bars 2 and 3 of the frame D, and it is moved up and down by means of two collars 4 and 5, which have arms H united by a bar 6. These arms carry rollers I, I', which are lifted by cams J, on the shaft K. There is a worm on the widdle part of K which turns the worm wheel L'. This is secured by a feather to the drill



spindle, so that it is turned continuously and uniformly. The frame D slides in gibs C' on the frame C, and is fed downward by the screw E. The nut E^1 is provided with ratchet teeth which engage with the pawl O. This pawl is moved back and forth at each stroke by the double cone on the N^1 of the drill spindle, which alternately strikes the fingers top and N^2, as shown in Fig. 3. The cams are double acting, moving the drill positively both ways, so it can be used in any position.

VARIABLE SPEED GEARING.

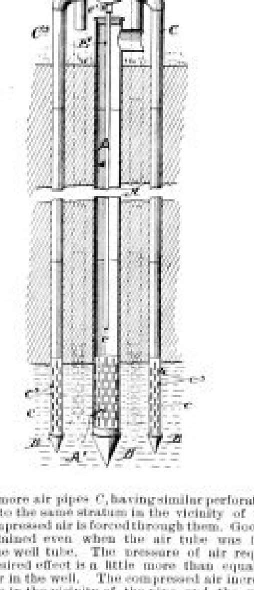
No. 546,060. Christian Seybold, Zweibrucken, Germany. *Patented Sept. 10th, 1895.* Fig. 1 is a rear elevation; Fig. 2 is a top view partly in section; and Fig. 3 is a section along the shaft B. The power is transmitted by friction from the wheel E to D, or the reverse, by means of a belt F, which is pinched between them. The face of the wheel E, is made concave, and that of D is made convex to suit. If these faces were made straight, the belt F could not be kept in place by any practicable means. By shifting the belt F, the contact between the two wheels is made



on differing radii, consequently the relative speeds are varied accordingly. The belt runs over flanged guide pulleys M, and it is shifted by moving the frame which supports them by means of the hand wheel and screw Z. To throw the wheels in or out of gear, the shaft B is moved endways, by means of a thrust box C, rack T, pinion S, shaft Q and wheel R. The weight G turns the wheel R and causes D to press upon the belt with sufficient force to drive properly; and by pulling on the rope P the wheels are disengaged.

RAISING WATER.

No. 546,125. Silas W. Titus, Brooklyn, N. Y. *Patented Sept. 10th, 1895.* When well tubes are sunk to water bearing strata, lying at considerable depths, it is frequently found that the pressure is insufficient to raise the water to the top of the well, or within reach of a suction pump. The object of this invention is to convert these wells into "flowing" wells, or to increase the depth of standing water in them to such an extent that the "air lift," process of pumping may be successfully applied to them. A represents the well tube, having its lower end provided with a strainer A', and being sunk to a water bearing stratum B. To drive the water into the well tube and thus raise its level therein, or to cause it to over-



flow, one or more air pipes C, having similar perforated ends, are driven into the same stratum in the vicinity of the well tube, and compressed air is forced through them. Good results have been attained even when the air tube was fifty feet away from the well tube. The pressure of air required to obtain the desired effect is a little more than equal to the head of water in the well. The compressed air increases the local pressure in the vicinity of the pipe, and the well tube affords the readiest escape for the extra pressure, consequently the water ascends in the well tube, mixed with fine air bubbles. Thus the water will flow as long as the supply of air is continued.

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Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING FOR PLACER GOLD.

ALMA PLACER, SOUTH PARK, COLO. A TYPICAL GOLD PLACER.

Showing how Large Quantities of Gold Bearing Soil is Handled to obtain Gold Economically.

(By Prof. Arthur Lakes, Golden, Colo.)

Placer mining will become more and more popular the more the present demand and search for gold is kept up.

At present prospectors with their habitual search for vein mines are hunting mainly for them; placers however are beginning to receive some share of attention; old long-forsaken placers are being looked up again; new ones are being opened, and large enterprises and in some cases novel ones are being started.

Whilst a gold-bearing vein in place may or may not lead to a rapid fortune, a placer when found, if fairly good, offers a chance for slow, but steady returns.

We have thousands of acres of placer ground in Colorado, more or less rich, scattered amongst the mountains, or by the banks of river and canyon. The origin of these deposits is mainly due to the glaciers that once held sway in these mountains. They mined the gold veins and the gold-bearing rocks on a gigantic scale, and carried down the debris of their work into the canyons and dumped it in their moraines along the sides. Floods and streams afterwards winnowed, sorted and rearranged these piles of rubbish, and the gold was distributed through the mass of material, or by its gravity found its way down to "bed rock."

Such morainal placer banks we often see especially among the river courses and ravines in the higher portion of the mountains. They are generally rolling banks of pebbles, often covered with grass and trees.

Besides these well known and more modern placers, experiments may be tried hereafter upon beds of coarse conglomerate sandstone of various geological ages and dates which we have been in the habit of looking upon as primeval solid rocks, but in reality they are ancient consolidated placers, and may or may not carry gold. In Colorado it might be well to look into such conglomerates, especially such as are made up of andesitic lava pebbles, also into loosely compacted andesitic breccias and tuffs, such for instance as form a large portion of the Conejos range. Cripple Creek has shown us that andesite is an eminently gold bearing rock.

The largest deposits of gold at the Homestake Mine in the Black Hills is derived from an ancient consolidated placer of Cambrian age. The hard gold placers of California are old placers hardened by time and pressure and covered by a protecting cap of lava.

The difficulty in the hard material of these ancient placers would be the process of crushing them on a large scale.

In modern placers the difficulty often lies in bringing a sufficient head of water for a sufficient length of time during the summer months to bear upon and work the material. Many a bank in some dry region has shown "good colors," but absence of water rendered it valueless, and in other localities thousands have been expended in bringing water by flume and ditch for many miles upon a placer bank known to be rich.

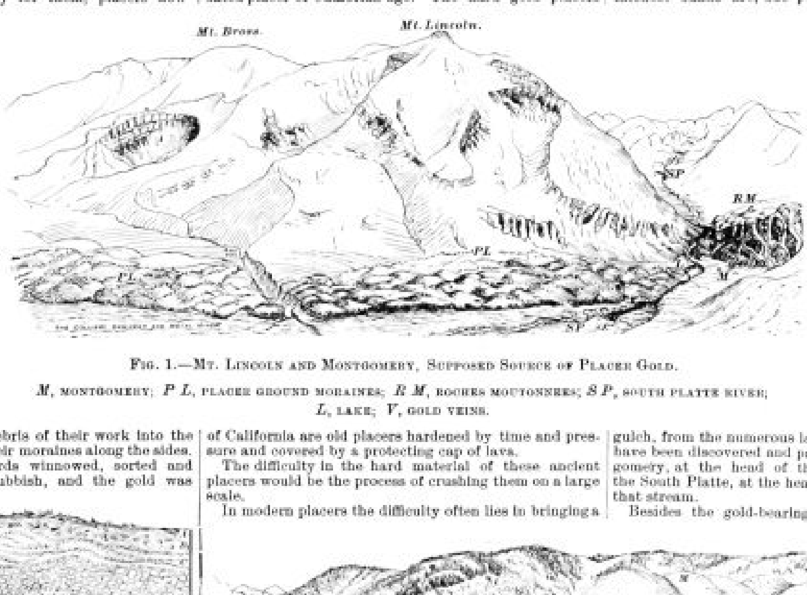


FIG. 1.—MT. LINCOLN AND MONTGOMERY, SUPPOSED SOURCE OF PLACER GOLD.

M, MONTGOMERY; *P L*, PLACER GROUND MORAINES; *R M*, ROCHES MOUTONNEES; *S P*, SOUTH PLATTE RIVER; *L*, LAKE; *V*, GOLD VEINS.

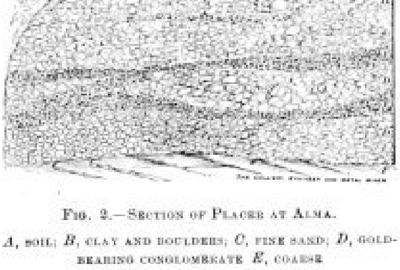


FIG. 2.—SECTION OF PLACER AT ALMA.

A, SOIL; *B*, CLAY AND BOULDERS; *C*, FINE SAND; *D*, GOLD-BEARING CONGLOMERATE *E*, COARSE GRAVEL; *F*, BED ROCK.

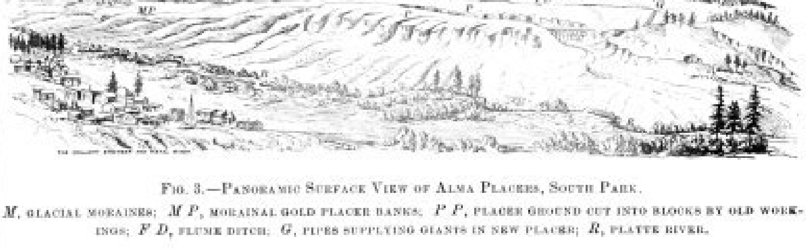


FIG. 3.—PANORAMIC SURFACE VIEW OF ALMA PLACERS, SOUTH PARK.

M, GLACIAL MORAINES; *M P*, MORAINAL GOLD PLACER BANKS; *P P*, PLACER GROUND CUT INTO BLOCKS BY OLD WORKINGS; *F D*, FLUME DITCH; *G*, PIPES SUPPLYING GIANTS IN NEW PLACERS; *R*, PLATTE RIVER.

SOUTH PARK PLACER BEDS.

In South Park, Colorado, at an altitude of 10,000 feet above the sea and 5,000 above the plains is an extensive area of placer ground, along the banks of the South Platte, stretching from Mt. Lincoln to Fairplay, a distance of twenty miles. This area consists of rolling banks of pebbles, boulders and sand, on both sides of the stream, covered with grass and trees, and sloping up gently toward the mountain sides for an average width of half a mile.

Portions of these placer-banks have been worked both at Alma and Fairplay, but are far from exhausted.

The principal workings are at Alma, where also the thickest banks are, due perhaps to the confluence of tributary canyons at that point.

There is a powerful body of water on hand, and the beds are being worked both night and day by the Green Mountain Company, under the superintendence of Mr. J. Fortune. Happening to be staying with a friend in South Park, we ran up to Alma and spent a week at the placer mine, for the purpose of mastering the subject in all its details as one of the most typical, extensive, and successfully worked placers in the state.

THE SOURCE OF THE GOLD.

To begin at the beginning of things, our first care was to take a trip with Mr. Fortune to the source whence we may suppose the gold came from originally.

This was doubtless mainly from the head of the gulch, from the numerous large gold-bearing veins which have been discovered and partially worked above Montgomery, at the head of the ravine above the valley of the South Platte, at the headwaters and main sources of that stream.

Besides the gold-bearing veins, the quartzites and porphyries of the adjacent region may have contributed a certain amount of gold to the placer, from gold disseminated through their mass.

The head of the canyon, below Mt. Lincoln, is the head also of the South Platte River, and was the starting point of the glacier that carved out the valley upon which the Alma Placers lie. The character of the predominant pebbles in the placer, viz.: quartzites, granites and porphyries indicates that the rocks at the head of the canyon were their principal source.

Mt. Lincoln is 14,400 feet above the sea. The peak is about 4,000 feet above the valley of the Platte. (See Fig. 1). The wall of the east face of the peak descends to the valley at Montgomery in a magnificent cliff of massive granite capped by quartzite and limestone beds with intercalated beds of porphyry.

The face of the granite cliff is traversed by an extraordinary number of large white parallel fissure veins composed of quartz and feldspar, having a general northwest and south-east direction.

The valley below is of a U shape, cut out of granite by the glacier. The rocks over which the glacier passed are rounded, polished and grooved, forming what the

FIG. 4.—DUMPING GROUND. MODE OF DUMPING REFUSE.

French call "*roches moutonnees*" or sheep-backs. These are exposed as the pavement of the upper part of the valley. And here over steps cut by the descending glacier, a violent stream tumbles in waterfalls—the source of the Platte.

Below, where the fall plunges into the valley, is a small shallow lake on a bench above the stream, which continues its course through a narrow ravine, and thence more slowly, down the valley to Alma.

This shallow lake half filled with gravel and pebbles is eyed hungrily and prophetically by the prospector, as a probable source of untold wealth, if it were only drained and worked, because here they think the gold accumulated by the glacier, by scooping out the upper part of the canyon and veins above the falls, must have first been deposited. A scheme has been projected by Mr. Fortune to drain this lake by "coffer-dam" and an underground sluice tunnel, the water of the lake with its debris passing through the coffer dam and tunnel, the giant nozzles blowing the sand and gold through the coffer dam and out through the sluices in the tunnel. Miners aver there is enough gold here to pay the national debt.

The veins in place in the cliff above have been tunnelled upon and worked with some profit. One in North Star Mt. shows bodies of solid iron pyrites together with a certain amount of free milling gold in decomposed sandy matter. Very little quartz is associated with the solid ore.

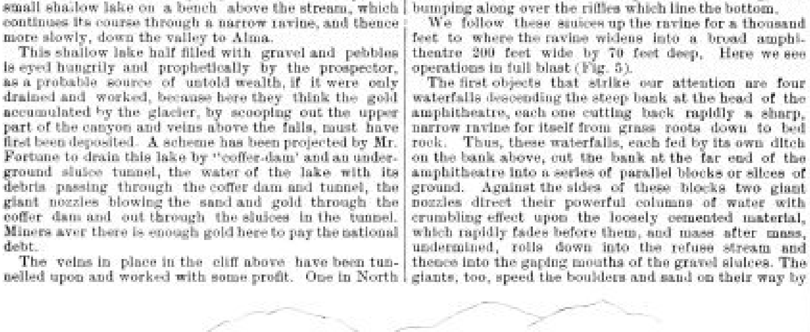


FIG. 5.—ALMA PLACER. *G, G*, GIANTS.

THE PATHWAY OF A GLACIER.

From this point we look down on numerous traces of the work and pathway of the ancient glacier. Vast bodies of great bowlders rise on the slope of the cliff 1,000 feet above the stream, with here and there an exceptionally huge block as big as a house dropped by the ice on the lateral or side moraine on either side the stream. The *roches moutonnees* fill the bottom of the upper part of the valley with their smooth rounded outlines like the bellies of a school of whales, grooved with long parallel grooves traceable from rock to rock, and many smaller scratches or "striæ." Between the moraines, the river runs in a long meadow with continuous banks of placer material on either side to a height of two hundred feet or more and downward to 50 feet. The surface of these morainal placer banks is very undulating, rising and falling in smooth grassy swells like the long swells of mid-ocean.

These banks are composed of what may be called modified drift, that is the rough, angular, original blocks left by the glacier have been worked over again by the stream, rounded and broken up, together with sand, gravel and flattened striated pebbles, the latter caught by the ice and ground down between it and the rock bottom under the ice mass.

SECTION OF A PLACER BED.

These banks when exposed in section, as at Alma, (Fig. 2) show a structure as follows, beginning from grass-roots. First a foot or two of black turf in which there is no gold, below that a foot or two of clay with pebbles in it, then a few feet of sandy layers irregularly bedded in streaks, as if formed by eddies and currents, this also is commonly barren or poor. The remainder to bed rock, from 30 to 50 feet, is composed of subangular pebbles and boulders of all sizes, from that of a marble to masses a yard or more in diameter. These are cemented together by gravel and sand which time, pressure and solutions of lime and iron-oxide have cemented into a firm conglomerate, which can only be attacked by the pick or by the all-destroying giant nozzle. Such are the placer beds for which we are indebted to glacier and stream.

ALMA PLACER BEDS.

These banks are continuous down both sides of the stream for 14 miles, but appear thickest on the East side and especially near the village of Alma and opposite the outlet of the tributary canyon of Buckskin Creek.

This is the site of the oldest and largest placer workings in Colorado. The banks have been cut back for a long distance, presenting a line of vertical cliffs 70 feet in height for about half a mile in length, channelled by narrow ravines and gashes, as shown in our illustration (Fig. 3), by the inroads of the giants and the cutting back of the flume waterfalls. Some of these cuts are short gashes not penetrating far into the hill, others lead through long narrow ravines into wide open amphitheatres, surrounded by channelled cliffs, whilst the center is occupied by tall piles of large boulders thrown out and piled up in the course of the work.

Wending through these piles of debris may be seen the pathways of the old abandoned gravel sluices, telling of the great work done and long since abandoned.

It is into one of these amphitheatres where work is still actively going on that we enter through a cut and ravine on the southwest end of the hill. From this ravine issue two long snake-like gravel-sluices debouching onto the open river bottom by many radiating mouths and shorter branch sluices (Fig. 4).

The water rushes rapidly along the bottom of these sluices and we can hear the big boulders rolling, and bumping along over the riffles which line the bottom.

We follow these sluices up the ravine for a thousand feet to where the ravine widens into a broad amphitheatre 200 feet wide by 70 feet deep. Here we see operations in full blast (Fig. 5).

The first objects that strike our attention are four waterfalls descending the steep bank at the head of the amphitheatre, each one cutting back rapidly a sharp, narrow ravine for itself from grass roots down to bed rock. Thus, these waterfalls, each fed by its own ditch on the bank above, cut the bank at the far end of the amphitheatre into a series of parallel blocks or slices of ground. Against the sides of these blocks two giant nozzles direct their powerful columns of water with crumbling effect upon the loosely cemented material, which rapidly fades before them, and mass after mass, undermined, rolls down into the refuse stream and thence into the gaping mouths of the gravel sluices. The giants, too, speed the boulders and sand on their way by adding their force to that of the refuse stream flowing from beneath the the waterfalls. So, sand and gravel and boulders are washed into the gravel sluices, the bottoms of which are lined with "riffles" or short cross-sections of the trunks of trees placed together like a lot of lozenges, or like a Nicholson block pavement. Both big and little boulders roll rapidly over this block pavement, and the gold by its gravity drops into the interstices between the blocks and is retained there. Its retention and deposition are further assisted by quicksilver thrown in, which has an affinity for gold and collects the finer particles in its soft, heavy mass.

Whilst the boulders and gravel soon find their way to the dumping ground on the open river bed, the gold in its travel stops long before this point is reached.

In the center of the amphitheatre a tall derrick moves a long arm around over the area by the power of a ten feet diameter Pelton wheel worked by water, and an undershot nozzle. The use of this derrick we see presently.

One of the flumes is stopped and its waterfall ceases, the giant nozzle is directed elsewhere, and the pathway of the stream becomes comparatively dry. Men gather into it and pick up the larger boulders, which are too large to pass conveniently through the gravel sluice. Some of these are so large they have to be blasted. The long arm of the derrick swings around and the boulders are placed in a large tray or stone boat suspended from the arm of the derrick and swung around to a convenient dumping ground on either side of the sluices. The larger boulders being removed, the gravel and finer pebbles become more exposed, and the nozzle is again brought to play on these, till at last bed rock sandstone appears beneath, full of cracks and crevices, forming by its gentle dip and irregularities natural riffles and catching places for the gold.

Now, the bed rock cleaners go to work and dig up and shovel into the sluice the rotten surface of the sandstone to a depth of a foot or so, below which, experience has shown, no gold passes. They also probe the cracks with their knives and pick out any stray nuggets that may be concealed there. (Fig. 6.)

Again, in the bed of the stream that descends from the flume, men are at work with long handled shovels "ground sluicing," *i. e.*, helping along some of the boulders, so as to keep the water in as definite a channel as possible and prevent it from spreading. (Fig. 6.)

Such is what the visitor learns in a general way at his first visit, leaving details for another time.

He is struck, however, with the magnitude of the work accomplished in so comparatively short a time, as well as with the enormous power of the giants and the cutting flumes, when he learns that, the whole ravine

FIG. 6.—"GROUND SLUICING" AND CLEANING BED ROCK.

and amphitheatre, the former 1,000 feet long and the latter 200 feet wide by 70 feet deep, has been worked out within the past six months.

After a day spent in an examination of the works we pass the evening with Mr. Fortune in his little cottage built on the bank above the placer and interview him over a pipe as to his mode of working the placer and the details of his work. He said:

MODE OF WORKING A PLACER.

"In undertaking a new placer enterprise the ground should first be well prospected and the certainty of the presence of gold assured. Shafts and prospecting holes must be dug down to bed rock to ascertain the depth of the formation. Prospecting and panning should also be done upon the sides of the gulches and other exposures.

"Then the water supply should be considered and water ditch and flume planned with a view to its power over the underlying bed rock. The grade of this ditch is a matter of consideration. If the grade is too great the water cuts and breaks banks, I have found a good average grade to be three-eights of an inch to a rod. 'Penstocks' or 'sand boxes' must be made and pipes attached. Pipes used here are 14 inches diameter.

"The giant nozzles, being attached and firmly braced to a platform on the ground, begin to play on some exposed part of the bank, also the ditch flume cuts a little canyon and blocks off ground, as you have seen, to be later broken down by the giants.

"The gravel sluices are then constructed for carrying the pebbles, gravel and gold with a general fall and inclination towards the dumping ground. In some cases the sluice is sunk down into the underlying bed rock. The sluices have curves and branch at the ends. The bottom of a sluice is lined with round riffles made out of sections of pine trees wedged tightly together with small stones in the interstices.

"After a ditch flume is let out over a bank it begins rapidly to cut a small ravine. The material, large and small, rolls down into the stream. To prevent the water of this stream from spreading too much and scattering the gold, men ground sluice it as you saw.

"The giant after a while is brought to bear and wears down the debris dislodged by the flume and drives pebbles, gravel and sand down into the gravel sluice.

"Water is shut off from one of the cutting flumes and made to play on another section, leaving the old channel dry. The 'ground sluicers' now remove all the big stones they can by help of the derrick and by blasting, till bed rock is reached, which is carefully washed and opened up with pick and shovel and searched with knives for a depth of two or three feet to a clay layer, below which no gold has been found to pass. Much of the decomposed bed rock is shovelled into wheel barrows and sent through the sluice.

"A smooth bed rock is not usually so rich as a rough one full of crevices. Bed rock is better, too, when on a

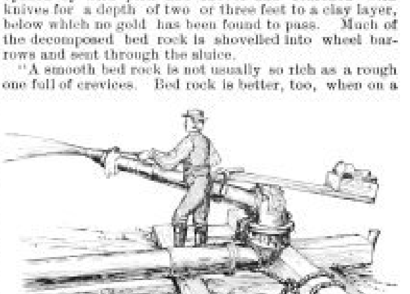


FIG. 7.—GIANT NOZZLE.

rise than in a hollow the gold being caught by its natural riffles.

"The richness of the bank depends on various conditions. The fine eddy top sand in the section is seldom rich. The best gold is generally in the coarser material or on bed rock. Sand is cemented by iron rust and pressure to the consistency of rock. 'Black sand' occurs here and there, and when it is rusty it is richest.

"There are often peculiar courses in the sand currents and turnings and windings, as in river courses. I think I have observed as many as three different periods of deposition in the material of the placer. The best explanation of the various changes, etc., in the deposits of a placer are to be found in studying those of a modern stream.

"The reservoir up the river supplying the ditches covers about five acres and is 10 feet deep. The dam is made out of gravel and brush cribbed with timber with a gate. The ditch is two miles long leading to the highest gravel banks and carries about 2,000 miner's inches of water flowing through it. It is 12 feet wide and 3 feet deep. It is flumed at one place on raised trestles for 240 feet. The flume is of boards 12 feet in length forming what are called boxes built with frames of 4″x4″ sawed

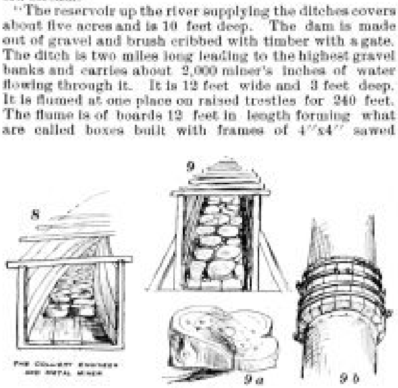


FIG. 8.

8, 9, SLUICES PAVED WITH RIFFLES; 9 a, WORN OUT RIFFLE BLOCK, ROUND SPOTS ARE PEBBLES FIRMLY STUCK IN IT; 9 b, STRENGTHENING A 16-INCH PIPE ACROSS A STREAM.

timber floor boards 1½″, sides 1½″. The flume is 6 feet wide and 3 feet deep. I had also in one place to cross a deep ravine of the old workings for 200 feet on trestles 50 feet high. At the end of this wooden flume on the solid rock is a flume 50 feet long at right angles to the trestle flume, from which there are four openings to ditch flumes which distribute the water to the general workings. The grade of the ditch was three-eighths of an inch to the rod. (Fig. 9)

"From the main ditch a branch ditch leads to the penstock or sand box. From that, two pipes are laid which at the penstock are 22 inches diameter but taper gradually down to the monitor or giant to 10 inches diameter. This pipe is 500 feet long. The giants also called "chiefs" or "monitors" are two in number and belong to the size known as No. 2. The discharge pipe is 9 feet long. The deflector by which the man in charge directs the nozzle in whatever direction he pleases (See Fig. 7) is attached to the end. The nozzle screws onto the deflector. The deflector works on the principle of a ball and socket, where the discharge pipe connects with the main casting there is also a ball and socket so that it too can be moved to right or left, up or down. Leather is used to prevent leakage at joints and saw dust is thrown into the sand box to stop leaks in the pipe at the joints. The "chiefs" are used for cutting down banks. The surplus water not used by the pipes is allowed to run over the highest part of the gravel bank to cut down and carry away gravel to the sluices. The pipes use 200 inches of water to each "chief." The ditches carry 2,000. The volume carries the gravel into the sluices."

GRAVEL FLUMES OR SLUICES FOR WASHING GRAVEL.

"These flumes or sluices are three feet wide by 4 feet high or deep paved with riffles 8 inches thick of varying width packed in the bottom of the sluices with small rock like a Nicholson pavement, Fig. 8.

So great is the force of the water in these sluices that boulders half a ton in weight are sometimes carried along from end to end. The velocity is about 25 miles an hour the dip, slope or grade is 4 inches to every 12 feet and 33″ to every 100 feet. This sluice is laid down on bed rock which is sometimes cut into to admit it.

"The curves of the flume are made like those of a railroad, raising on the outer part of the curve. There are two parallel sluices 30 feet apart.

"When these two main arteries reach the bed of the river which is their natural dumping ground, branches are formed (See Fig. 3), so as to spread out the material in a fan shape and these branches are extended as the material accumulates.

"The sluices are 4,000 feet each in length. The riffles protect the boards on the bottom from the wear and tear of the gravel and boulders. Old riffles are left in the bottom of the branches were no gold is collected for this purpose. The gold is mostly found deposited in the first 400 feet of each sluice.

"The derrick or hoisting gear is run by water when it hoists up the big rocks with a 'cab' or 'stone boat' by a 'gin-block' and chains. The water is led in an 8-inch pipe from the sand box to an undershot Pelton wheel with 1⅝-inch nozzle. The wheel is 10 feet in diameter. The drum is worked on the V friction principle.

"Quicksilver is thrown into the flume among the riffles from a bottle, we estimate about 2 oz. of quicksilver to one of gold.

"In a 'clean up' which occurs at irregular intervals, we first take out the riffles and let on water to wash everything clean. We take out the packing of small rock with twelve-tined forks. The floor is then quite clean, the gold being all collected by the quicksilver, usually at about 200 feet from the entrance of the flume. The quicksilver is shovelled out and separated from black sand and carried in kettles to the retorting office, retorted there and prepared for the mint."

After our talk, as Mr. Fortune had to see to the "night shift" of workmen, we went out on the hill to look at the placer by star light. It was a weird sight to look down on to the dark abyss of the plain with elfin light flickering to and fro from the men at work, and the great giants shooting columns of flame as it seemed into the abyss, the water from these reflecting the flames of a bonfire built on the bank. The main danger at night is the fear of flumes bursting or breaking their banks.

TREATING AMALGAM AND RETORTING.

The following epitomized from Lock's gold mining is the process for extracting the gold from the mercury amalgam.

The amalgam as collected, whether from sluices when working alluvial deposits or from plates and riffles when dealing with veinstuff, in large establishments and is carried into an apartment containing a table slightly inclined with a grooved surface near the lower end, and a hole at the lowest point opening into a receptacle for catching any mercury that may escape.

On this table is an iron kettle large enough to hold all the amalgam collected in a single "clean up." Into the collected amalgam and mercury some sodium amalgam—one ounce to each flask of mercury—is introduced, and the whole is stirred. After some time, water is poured into the kettle above the mercury, and stirred. Sand and mud rise to the surface and are removed with a large sponge. Washing and stirring continues until the surface is comparatively clean. The mercury is then made as dry as possible with the sponge and the whole stirred again with the hands. Some dirt generally arises which is scraped of with a dry card or piece of leather drawn gently edgewise over the surface. This is repeated till the mercury seems clean.

It is then poured into conical bags of canvas or chamois leather, through the pores of which the mercury runs, or is squeezed leaving the gold amalgam in the bag. A certain quantity of gold is retained by the mercury which can only be recovered by retorting but it is not desirable to do this if the mercury is to be used for further amalgamation, as the presence of gold increases its activity. The retort is a deep cast iron vessel shaped like a bowl; on top is a jointed iron from which an iron tube rises and bends downward. A mixture of wood ashes and clay is prepared. The balls of amalgam are placed in the bowl and the ashes put thickly around the edge. Cover is fitted. Clamp adjusted. The retort is placed in a furnace over a moderate fire. The end of the pipe dips just below the surface of water placed in a vessel. When the retort has attained a dull red heat and no more mercury distiles over, the retort is allowed to cool. The cover is taken off and the bullion removed. The amalgam after retorting has a gold metallic color. It is ready for the melting pot as soon as taken out. Gold from a placer is usually deposited in the local bank and thence goes to the mint for refining.

The sodium amalgam must be freshly made to be effective. If kept long it oxidizes. Metallic sodium may be kept in wide mounted bottle covered with coal oil. Enough for a single "clean up" can be made in a small frying pan.

A small quantity of mercury from a fresh flask is poured into the pan and dried with a sponge and then heated beyond boiling point but not enough to volatilize the mercury.

A piece of sodium is cut into one-half inch cubes and the mercury taken out into the open air. A cube of sodium is placed with tongs in the center of the warm

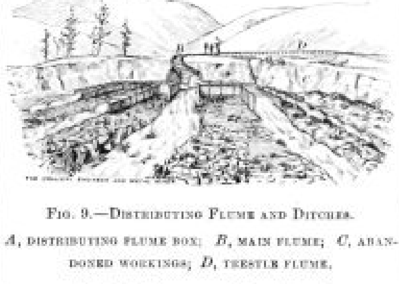


FIG. 9.—DISTRIBUTING FLUME AND DITCHES.

A, DISTRIBUTING FLUME BOX; *B*, MAIN FLUME; *C*, ABANDONED WORKINGS; *D*, TRESTLE FLUME.

mercury. A flash follows, a small portion of mercury is volatilized, another cube of sodium is placed with less flash. This is repeated three or four times when the sodium sinks down gently. At the proper moment a solid mass of amalgam will appear in the center. The contents of the pan are then stirred and a few more added cubes change the whole to a mass of crystallized sodium amalgam.

Meritorious Machinery Appreciated.

The Robinson Machine Co., of Monongahela, Pa., inform us that their foundry and machine shop are running full time and with a full complement of men, in the construction of hoisting, haulage and ventilating machinery and tipple arrangements. Among the recent orders received by the Robinson Co. are the following: A three drum hoisting engine for the Clipper Sand Co.; a two drum haulage engine for the California Coal Co., of California, Pa.; endless haulage machines for the Oliver Coke and Furnace Co., Pittsburgh, Pa., and the Royal Coal and Coke Co. of Knoxville, Tenn. A single friction drum haulage engine for the Hopkins Coal Co., of Perryopolis, Pa., and a large ventilating fan for the P. J. Forsyth Coal Co., of Coal Centre, Pa.

Among the orders received for complete tipple rigging are those from the following companies: The Equitable Coal Co., Webster, Pa., Hopkins Coal Co., Perryopolis, Pa., and the Belle Bridge Coal Co., Pittsburgh, Pa.

Written for THE COLLIERY ENGINEER AND METAL MINER.

A FLUME CONVEYOR.

By L. S. Ropes, B. S.

Your space permitting, I will add a few words on the subject of Mr. Lloyd's interesting article in the October COLLIERY ENGINEER AND METAL MINER.

At one of the old corundum mines at Corundum Hill, Macon Co., N. C., such a conveyor has been in use for a number of years and the experience here has suggested means of overcoming some of the difficulties met with in the above case.

A flume is just about completed from the Foster Mine on Ellijay Creek from the top of the mountain to the mill on the creek (now under construction). This flume is about a mile long and its fall about 800 or 900 feet.

Briefly the troughs are 10 and 12 ft. long, the bottom boards are sawed 10″ for the upper end and eight for the lower, so that the joints telescope and are nailed together with 10d. nails and a cleat 1″ x 4″ nailed across the top of the outside trough to prevent spreading, and with some a collar is made about the middle of the trough. The plank used is one inch oak and the sides are eight and ten inches high. In turning a curve or angle the side boards are beveled, one side of the lower trough inside, and the opposite outside, of the upper trough. At every joint is a one inch fall which should be changed as excessive wear, comes at this point. As the bottoms wear false ones are put in.

With plenty of fall but little attention is paid to grade except where a noticeable change occurs, then, to prevent damming of the material a vertical drop of two feet or more is made by fixing to the lower end trough of an even grade, a tight box opening at the bottom into the upper trough of the next regular grade. Should the following grade be the flatter one a small head may gather in the vertical column and give velocity to the material.

Where possible, a high "jump off" is given, this assisting in breaking up the loosely compact sand, clay and vermiculite which make up the gangue of the corundum vein and further in separating by allowing the light material to race. The troughs are charged at intervals. In this way there is no damming and overflowing. The climate being mild, no covering is used over the trough.

As a post script allow me to note that the Foster-Ellijay mines are nearly developed and will commence milling from stockpiles which have been accumulating for a number of months past. This with the old Corundum Hill mine are the only two in operation; many prospects in this and adjoining counties are being brought before mining men and with the advent of the railroad it is thought that some of the grand water powers and forests of these mountains will be turned to the use of man.

A wealth of power and timber with raw material lies dormant awaiting the key, a railroad, where capital will quickly discover the advantages. An abundance of good food and most healthful climate will bring the laborer.

But must capital await a railroad? We are but twenty miles away and have the chief factors to the economical production of aluminum and calcium-carbide, viz. the raw material and the *water power*, the latter with high heads and abundant flow.

Pressure Recording Instruments.

Bristol's Recording Pressure Gauge is rapidly coming into great favor among mine managers, as a medium through which the condition of the ventilation of a mine can be accurately and constantly checked. Every mine fan should be supplied with some appliance by means of which the work of the fan can be accurately and constantly gauged. In some States the mine law requires that either a speed or pressure recorder be applied to each fan. Speed recorders are far better than nothing, and as they were placed on the market before pressure recorders, they were adopted by mine managers who desired the best possible method of gauging the work of a fan. The pressure recorder is far more efficient than a speed recorder, because it furnishes constant and direct evidence of the efficiency of the ventilating current. A speed recorder does not do this with the same degree of accuracy. It merely records the revolutions of the fan. If an open door, or a fall of roof occurs in a mine, the fan may continue running at normal speed, and the volume of air may be reduced to a remarkable, and in some gaseous mines, to a dangerous degree. The pressure recorder acts differently. If there is any derangement of the air passages it immediately records a change in the pressure of the air current, and the degree of change as compared with the normal pressure gives an idea of the extent of the derangement. If the speed of the fan changes from its normal number of revolutions, the pressure recorder records it by noting the change of pressure due to the change of the periphery speed of the fan. When these features of the recording pressure gauge are considered, it becomes evident to every practical mine manager, that it is a far more efficient and valuable appliance than a speed recorder.

The same principles that are embodied in the construction of the recording pressure gauges for use in connection with ventilating machinery, are applied by the Bristol Co. to recording pressure gauges for steam, gas, etc.

Thesame company also manufacture recording vacuum gauges, recording thermometers, recording volt meters, recording amper-meters for both direct and alternating currents, and recording watt meters.

The value of each of these appliances in the various fields for which they were designed is obvious to every reader.

In laying out the holes in a belt for the lacing, do not get them too near together, for while this practice makes the finished lacing stronger, it makes the belt weaker, on account of the large amount of material cut away in making the holes.—*Power.*

Written for THE COLLIERY ENGINEER AND METAL MINER.

GOLD AND SILVER MINING.

TIMBERING FOR PRECIOUS METAL MINES IN COLORADO.

The Methods of Working and Conditions Which Influence the Methods of Timbering.

By Francis T. Freeland, B. S., C. S. S., A. S. M. E., A. I. M. E.; Gen'l Mgr. Aspen Contact Mg. Co., Lenado; Durant Mg. Co., Aspen; Isabella Gold Mg. Co., Cripple Creek, Colo., etc., etc.

The styles of timbering for precious metal mines differ materially from those used in coal and base metal mining and also show variations in different sections of the country. The Nevada practice is described by Hague and Curtis, and that of California by Storms. Ricketts refers briefly to some designs used at the Morning Star mine, Leadville, Colo.*

I have shown in the accompanying plates a number of patterns largely and successfully used in Aspen and Leadville. The drawings are to scale and dimensioned so that they may be used for working drawings if so desired. No attempt has been made to illustrate forepoling or spiling, breast-boards, stulls and cribs, as they have been often given, nor to describe methods necessary in unusual or difficult cases. In treating of timbering it was found inadvisable to avoid all reference to methods of mining, as is sometimes done, for success depends not entirely upon knowing how to set a stull, erect a square set, or plumb a shaft. It is just as important to know what style and dimensions of framing to use with the various kinds of ground, shapes of ore bodies, methods of mining, plans of development and the hoisting appliances adopted.

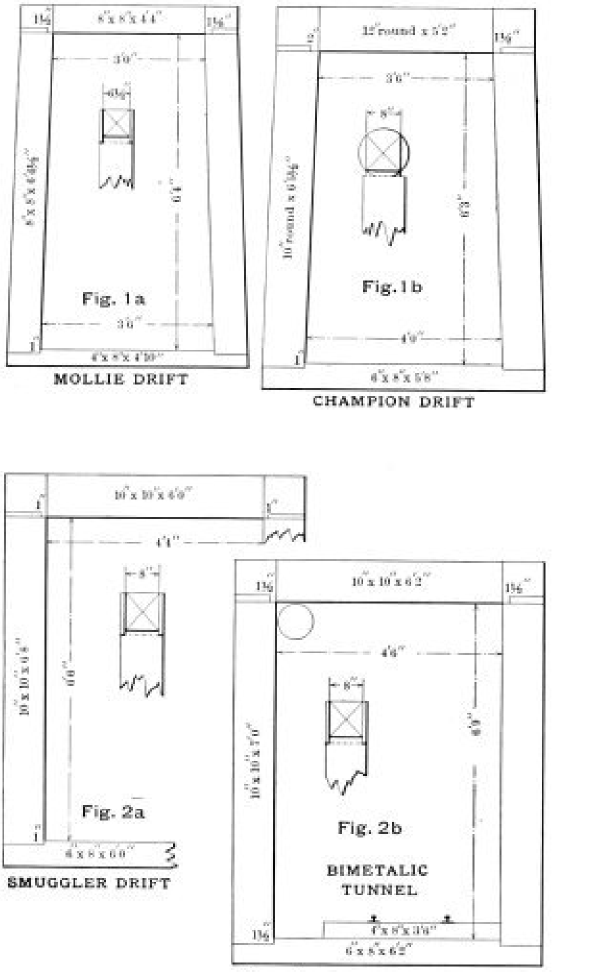


Plate I.
Scale [illegible]

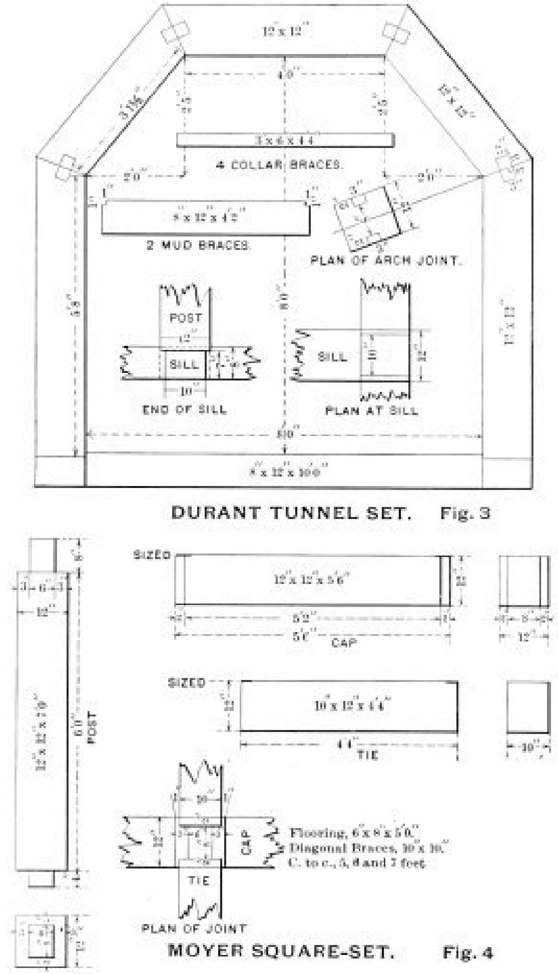


Plate II.
Scale [illegible]

DRIFTS.

The usual mining cage-car is square bodied, turns and dumps at the end. The box is 2′ by 2′ 2″ by 2′ 6″ and contains 15 cubic feet. The car stand 3′ 3″ from the track and runs on 10″ loose wheels upon 8 lb. track of 18″ gauge. Plate I, Fig. *a* shows the smallest size drift in which such a car can be worked conveniently. This is the standard drift set in the Mollie Gibson mine at Aspen, W. J. Cox, Supt. The height will allow for a sheet-iron ventilating pipe overhead. In that mine in the wet drifts the track is laid on 4″ stringers to form a waterway all over the floor. Otherwise 6′ height would be the minimum.

The drift set of the Bohn mine, Leadville, is rectangular, 3′ 6″ by 6′ of 8″ by 8″ squared timber with 4″ by 8″ sills. The posts are 6′ 4″ over all and the tenon at the top is 6″ by 6″ by 2″, flush on the outside of the set, with a plain foot. The boxes on the sill are 8″ by 2″. The boxes for the collar braces are 1″ deep. I also have used this set largely in the Durant mines in medium ground. In heavier ground, 10″ by 10″ timbers are used with the same size of jogs but with a 6″ by 10″ sill. Plate I, Fig. 1*b*, shows the standard drift set used by the Mineral Farm Cons. Mg. Co., Aspen, designed by the writer. This mine is worked through the Cowenhoven tunnel, and the drift could not be smaller and yet take the tunnel cars, (See description of Cowenhoven tunnel below.)

Plate I, Fig. 2*a* shows the standard drift set used in the Smuggler mine, Aspen, S. I. Hallett, Supt., a more roomy design and suitable for main levels. The Aspen mine uses a cage-car, 2′ 6″ by 2′ 6″ by 4′, but they are rather large for a high grade mine. The Aspen Contact standard drift set is 3′ 10″ by 6′ 4″. The El Paso standard drift set, Leadville, is 3′ 6″ by 6′ 3″, timbers 10″ by 10″ and sill 4″ by 10″ or 8″ by 10″, squared and rectangular.

TUNNELS.

Plate I, Fig. 2*b* was designed by the writer for a single track tunnel in the Bimetallic mine at Lenado near Aspen, ½ mile long. It contains a water way over the sills and is as small as can be worked with a mule. The standard single track section of the Compromise tunnel, Aspen, ½ mile long is 5′ x 7′. The cars have boxes 3′ by 3′ by 5′ and one mule will pull 4 in a train.

Plate II, Fig. 3 shows the standard section of the Durant tunnel, Aspen, 1 mile long. A boxed waterway 12″ by 16″ of 3″ plank runs under the sills. The grade is 5″ to 100′. The cars have turning scoop beds holding 20 cu. ft. and run on 12″ fixed wheels with 22″ gage on 30 lb. rails. The draw-bars are on the trucks. One horse will pull 10 cars. It will be seen that the collar braces lock the arch. The Castle Creek tunnel, ½ mile long, resembles this set, but is 7′ 6″ high by 8′ wide. The drain is 16″ by 16″ and the grade 6″ to 100′.

The Cowenhoven tunnel at Aspen, about 2 miles long, designed by D. W. Brunton, Mgr., is about 6′ 6″ by 7′ and is timbered with octagonal and trapezoidal sets. The gauge is 18″ double track, 22 lb. rail. The waterway 12″ by 14″ is under the sills between the tracks and covered by a plank walk. The grade is 6″ in 100′. The cars turn and dump from the end and have the bumpers on the box. They are 3′ 2″ by 2′ 4″ by 4′ 1″ holding 20 cu. ft. They stand 4′ 4″ above the track and run on 12″ loose wheels. Full throw switches were found an advantage on the main line for then no frogs interrupt the continuity of the rail. One mule with a driver pulls 10 cars.

The Revenue tunnel, Ouray, H. W. Reed, Supt., about 8,000 feet long is 8 by 8 feet with 14 inch caps and 12 inch legs. The track is double, 2 feet gauge and the cars are 4′ 11½″ by 3′ 3½″ wide by 2′ deep on 12″ wheels. The air pipe is 4″ and the ventilating exhaust pipe 15″. Rack-arock powder was used as giving less smoke.

The Newhouse tunnel, Idaho Springs, designed by W. H. Wiley, Mgr., is similar and 7′ by 8′, timbers 10″ by 10″ and sill 6″ by 10″. The water drain is under the sills and 12″ by 24″. The mud braces are rough and the collar braces 6″ by 6″. The track is double of 18″ gauge and 30 lb. rails. Grade is 5″ to 100′. The cars have a capacity of 27 cu. ft.

The arch form is stronger only where the pressure is uniform. Space must be allowed for the various pipes and wires the tunnel is to contain. For a single track tunnel the waterway may be formed over the main sills by laying a floor on plank stringers set on edge, having made proper allowance in the height. A tunnel can be driven faster if it is wide enough for two air drills to be set on columns abreast. A 7′ by 9′ or 10′ section can be driven faster than 8′ by 8′ as the center cut breaks better.

Bad ground often occurs in depth as crevices or chambers filled with loose material carrying water under pressure. They can usually be penetrated by spiling and breast boards; or by setting the cap first, supported on temporary longitudinal stringers. With a large section, flanking small drifts may be sent out to drain and thus consolidate the ground. In continually swelling ground a second light set may be erected outside of the main set, the ground to be eased when the lagging bends and the light set to be replaced when broken. This will save the main set and prevent interruption of traffic. It is better to use light open lagging in heavy ground so that it may break before the set.

In this sort of mining no heading machines are used, and no application of the shield, or pneumatic processes have been made in driving. The drilling is done by percussion drills driven by air.

Long tunnels may be ventilated by an exhaust fan or steam jet, to keep the bad air out of the tunnel. But in most cases and especially for raises forced ventilation by fan or jet driven by compressed air is best as the fresh air goes to the place where most needed and at once. The air drills themselves will supply a certain amount of fresh air, but the practice of opening the

* The Ores of Leadville, by L. D. Ricketts.

compressed air pipes for ventilation after shooting leads to waste.

Tunnels and drifts are aligned by sighting over two plumb-lines to a light at the face. The hubs are set a convenient distance from the face by a transit or special tunnel instrument. The sills are set by a grade stick and carpenter's level checked by a surveyor's level from time to time. The grade of an ordinary drift is usually from 6 to 9 inches in 100 feet.

RAISES.

Plate VI, Fig. 13 shows a prospecting raise, about the smallest that can be driven and timbered, containing a manroad and chute. The ends are made to overlap the sides to reduce the weight of the heaviest piece. These raises may follow the contact and change grade with it by altering the length of the posts. A common way of timbering raises is to place two lines or stulls about 4′ apart with a loose plank on each pair, but it is neither safe nor convenient for a considerable height.

In Aspen a number of important raises have gone up from the Cowenhoven tunnel, some of them 500′, at an elevation of 50 to 60 degrees. Plate VII, Fig. 15 shows one on the Mineral Farm property, containing chutes for ore and waste and a manway. In the manway runs a timber truck straddling the ladder road and hoisted by a windlass or engine. These raises follow the contact nearly and are run at a uniform grade. Levels are turned off at intervals of 50 to 100 feet and the rock is dumped down the chutes which are lined on the bottom and sides, direct to the tunnel cars from bins.

SHAFTS.

A small bucket shaft or shaft winze may be 3½ by 7 or 4 by 8 feet with a square bucket way and solid partition. The buckets will usually hold ½ ton of rock. The principal shafts are provided with cages, and the great majority of hoist ways are 4 by 4½ or 4½ by 5 feet. Two compartment shafts vary from 4½ by 9 to 5 by 10 feet, and three compartment shafts from 4½ by 13 to 5 by 16 feet. The largest shaft in the state is the Bobtail, above Central City. It is 8 by 16 feet, with four compartments, hoisting cars containing 32 cu. ft.

Shafts are usually either cribbed or setted. Plate III., Fig. 6, shows a crib used at the A. Y. mine, and Plate VII., Fig. 16, the Jamie shaft, Leadville. The size of the timbers varies with the character of the ground from 4 by 8 to 8 by 10 inches, often 6 by 8 inches. The new Star shaft on the Penrose mine, Leadville, is 4′ 6″ by 9′, cribbed with 8″ by 8″ timbers. Each side and end piece is boxed four times at the corner 1½″ by 8″. The partitions are solid of 3 or 4 inch plank confined by 2 by 4 inch strips or angle pieces of diagonally sawed 4 by 4 inch. The cribs are built up in stretches of 8 to 12 feet on hitched special end pieces, or in smaller stretches hung up by iron dogs, when in firm ground. Cribs are nearly as cheap, are easier to frame, require less space and are stronger in bad ground than sets. But they can only be relieved by cutting them out and cannot be aligned anew without replacing them, and are not so convenient for hanging pumps, pipes, or setting platforms.

[TO BE CONTINUED.]

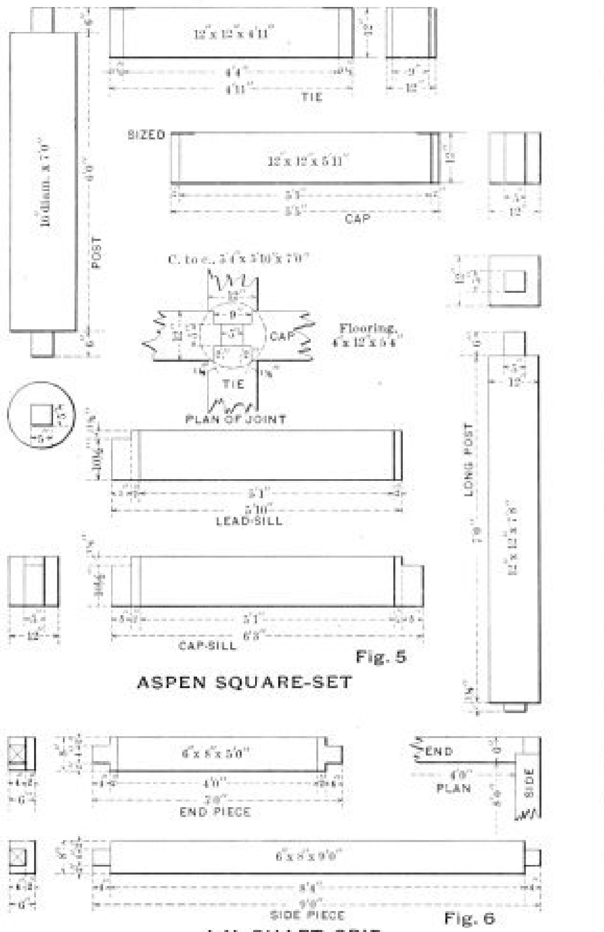


PLATE III.
Scale 1/48.

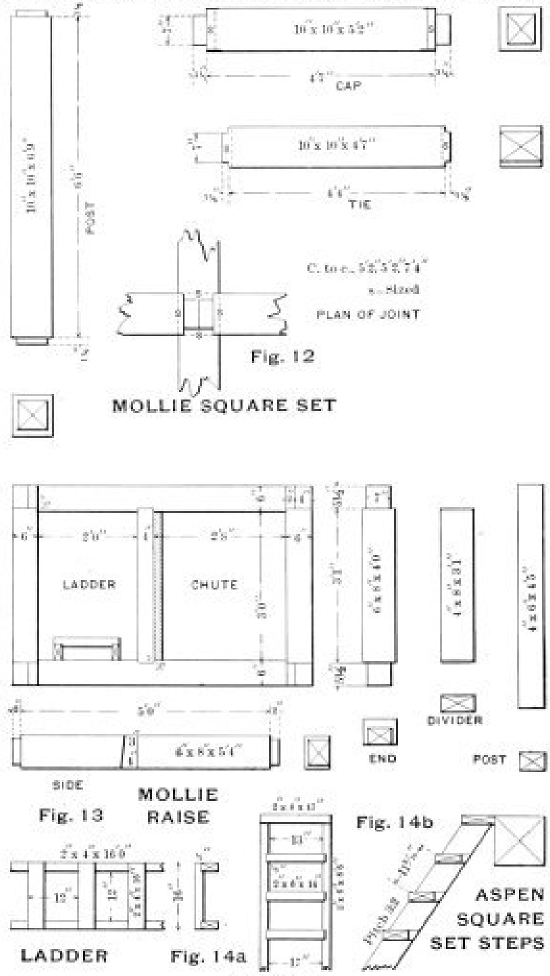


PLATE VI.
Scale 1/48.

Written for THE COLLIERY ENGINEER AND METAL MINER.

IRON ORE MINING.

The Mining and Washing of Iron Ores at Scotia, Pennsylvania.

(By H. H. Stock, E. M., State College, Pa.)

The recent development of the Mesabi range in Minnesota, in the United States, quite largely by the use of the steam shovel or excavator, has attracted unusual attention to this tpye of mining. While it has been used somewhat in other localities in the eastern and southern portions of the United States, for the stripping of coal beds and the mining of the soft, brown ore deposits, the use of the steam shovel in connection with iron ore mining is generally considered a novel departure. It may therefore be of interest to recall that for the past fifteen years it has been in almost constant use in the very center of the great Commonwealth of Pennsylvania, and that before a single ton of ore had been taken from the Mesabi field, over half a million tons had been thus mined at Scotia in that State and shipped to Pittsburgh, for smelting.

The mining and smelting of iron ores in Central Pennsylvania is by no means a recent industry, and the history of the same is intimately and almost inseparably connected with the general local history from a period antedating the opening of the present century. On all sides, and often in the most unexpected places are found the evidences and relics of a former busy industry, in the form of an overgrown cinder bank, an old stack or open hearth, a mossy water wheel or whatnot. The mountain sides, denuded of their trees, tell a similar story of former activity, for long ere the much blamed lumber interests had begun their campaign of deforestation the charcoal burner had begun, and ofttimes, completed the work of destruction. The life of many an early furnace was determined by the distance to which it was economical to carry the needed charcoal, for the limestone and ore were abundant and easily obtainable, while the latter, easy to smelt and of exceptional purity, produced an iron deservedly celebrated for its working qualities.

The old Centre furnace, situated about one mile to the east of State College, but abandoned thirty years ago, serves as a very good type of one of these early workings. At first ore, limestone and charcoal could be gotten within almost a stone's throw of the stack, while the power for turning the water wheel came from a huge spring near by, still used for a saw mill and a flour mill, the former situated nearly on the site of the old furnace. The pig iron was hauled down the mountain to Bellefonte and there either converted into muck bar or shipped away over the canal. The area from which came the charcoal supply gradually widened until the long haul of two days for each load of charcoal became prohibitive. The foundations of the old furnace still stand, suggesting and recalling the characteristic scenes of old forge life and activity which are now so rapidly disappearing. In those good days it mattered little in these mountain valleys whether a single or double money standard ruled the country, as the only currency seen in the community was that brought in by an occasional traveller, while wages and all local wants were satisfied by barter through the medium of the company store.

The numerous charcoal furnaces of the region have been replaced and supplanted by two modern blast furnace stacks located in Bellefonte and owned by the Valentine Iron Company and the Collins Brothers.

The Scotia mine was formerly owned by the Centre Furnace Company, but was purchased in 1881, by Carnegie Bros. and Co., now the Carnegie Steel Co., and has since been operated by them.

The geological relations of the Centre county deposits are very like the many similar surface formations found in eastern Pennsylvania and extending parallel to the Atlantic seaboard until finally lost in the extensive deposits of brown ores in Alabama. These deposits have been described in detail in the reports of the Second Geological Survey of Pennsylvania, but in brief they may be said to be pocket deposits occurring in the lower Silurian limestones and irregular both in form and distribution.

Two varieties of ore occur, the wash and the lump hematite ores, which constitute the bulk of the Scotia ore, and the pipe ore found in other sections intimately connected with the first variety. The designation "wash ore" suggests the theory of formation advanced by the geologists of the State Survey, who suppose these beds to be wash deposits of rolled ore, stiff clay, sand, etc., which have been transferred from other localities, and finally imprisoned in the huge caverns existing in the native limestones.

The ore banks of Centre county have been divided into seven groups, the most important probably being the "Barrens Group" of which the Scotia deposit forms a part. This property comprises 430 acres and before the change of ownership in 1881 it was thoroughly prospected by the present owners by means of pits and drill holes. These tests showed only a portion of the property to be underlaid by the ore bank, but in a number of instances pits sunk eighty feet in depth were still in the ore body. According to the calculations of the owners, one million tons of washed ore will be taken from the bed, of which six hundred and fifty thousand tons have been already mined, while at the present rate of working the bank will be exhausted in about six years from the present time.

The ores vary both in color and value, the darker colored pitch like ore being richer than the lighter liver colored and more compact ore.

A mine classification to size is also made in the lump ore, which is shipped in the form in which it is

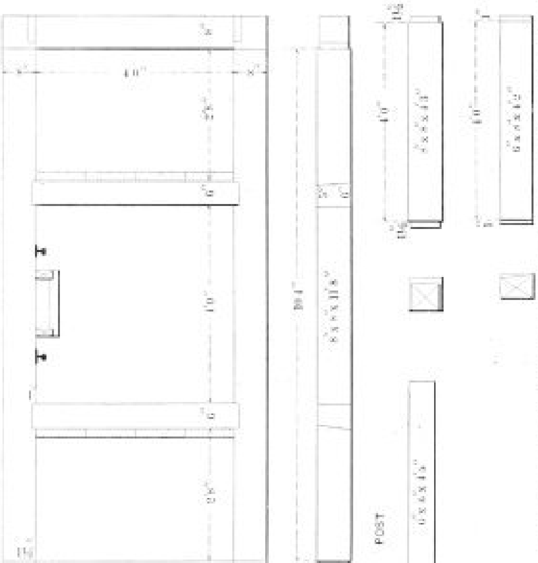


PLATE VII.
Scale $\frac{1}{40}$.

mined without further breaking or washing, and the "fine ore" which is that passing through bars placed six inches apart is broken, washed, and picked before shipment.

ANALYSES OF SCOTIA ORES.

	Sample No. 1.	Sample No. 2.
Bi-Sulphide of iron		
Protoxide of iron		
Sesquioxide of iron	75.443	64.821
Sesquioxide of manganese	0.578	0.392
Sesquioxide of cobalt	0.020	0.010
Alumina	1.851	2.973
Lime	0.860	0.650
Magnesia	0.336	0.280
Sulphuric acid	0.225	0.275
Phosphoric acid	0.116	0.116
Carbonic acid		
Water and carbonaceous matter	9.669	9.184
Silicious matter	11.450	20.730
	100.348	99.651
Metallic iron	52.950	45.374
Metallic manganese	0.403	0.273
Sulphur	0.091	0.170
Phosphorus	0.051	0.051
Phosphorus in 100 parts of iron	0.096	0.112

In the earlier reports of the State Survey the heavier ores are stated to lie at the bottom of the deposit but the later development of the Scotia bed has shown the character of this deposit, at least, to be very uniform throughout.

The foregoing analyses of the Scotia ore were made in 1881 by the chemist of the Second Geological Survey, Mr. A. S. McCreath:

Sample No. 1 represents 490 pieces selected from different parts of the ore pits and thoroughly dried.

Sample No. 2 was of thoroughly washed and dried ore taken from different parts of the ore pile.

The early estimates of the State Survey gave the iron content of these ores as 44–52%, and the phosphorus as 0.08–0.20%, but according to the developments up to the present time, while the iron has averaged only 40%, the phosphorus content has likewise been lower, 0.05%, thus compensating somewhat for the smaller amount of iron. The lump and fine ores are kept and shipped separately, as the former contain 40–50% of metallic iron, and the latter only 35–40%, while the amount of phosphorus is constant, and neither contain sulphur.

Mining is carried on with the steam shovel, three excavators of the Otis type, made by John Souther & Co., of Boston, being in active and continuous operation at the present time, two working in the older, or northern portion of the mine, and a third opening up the southern extremity of the deposit, near the old "Red Bank" mine, belonging to the Collins Bros. of Bellefonte, formerly also operated with the steam shovel. These excavators are of the ordinary scoop or drop bottom bucket type, with a lateral reach of 17–18 feet, thus giving a cut 35 feet in width. A vertical cut of 16 feet is taken, but an allowance of from four to nine feet is made for the topping, which falls when undermined, thus making the actual vertical excavation 20–25 feet in height. The track upon which the excavator runs is laid in sections two feet in length, and the excavator is moved forward over one or two sections at a time, depending upon the character of the ground being worked. The ore and accompanying clay and sand are removed in mine cars with a capacity of 32 cubic feet each, and as the excavator scoop shovel holds about the same amount, a car can be filled at each swing of the bucket. A single track runs parallel to the excavator track, on which the cars are removed and put in place with a mule driven by a small boy. Considerable time is lost in the loading of the cars, as a single track only is laid near the excavator, and the empty car must thus wait until the loaded is switched to the side track, where it forms part of the train of 24 cars, which is drawn to the washer, half a mile distant by a small "dinkey" locomotive. The estimated capacity of the excavators working under the conditions at Scotia is 350–400 cars per day (415–474 cubic yards) and they are assumed to replace 25–30 laborers shoveling and loading by hand, though these figures are very much smaller than those given by Mr. Robinson in his article upon the steam shovel in the January number of Cassier's Magazine, and also by the manufacturers of the shovels. The crew of the excavator consists of the engineer, the cranesman and the fireman, while working about the machine are a foreman, two pit shovelers, track layers, etc., and two mule drivers. Assuming a laborer's wages to be $1.00 per day, and that it takes half a ton of coal per day to fire the excavator boiler, (the makers estimate only 700 lbs. per day), with the above force of workmen and with the usual difference between the wages of engineers, firemen, etc., taking the value of coal as $2.00 per ton, the cost of operating an excavator will be $10.55 per day of nine hours, or 2.64 cents per cubic yard of material excavated. If the excavator displaces only thirty men, as assumed above, the wage account of the same, including a foreman, would be at least $31.50 per day, or nearly three times as great as steam shovel work. If, on the other hand, we assume, as does Mr. Robinson in the article before quoted, that a laborer can dig and load not more than four cubic yards per day, the Scotia excavator can be assumed to replace 100 men, with a probable wage account of $105.00 per day, or 26 cents per cubic yard. The above figures are not given as the actual results attained at Scotia, which cannot be secured for publication, but are merely estimates based upon the wages paid in this locality.

The mining is carried forward by the simple open cut method, sections 20–25 feet thick and 35 feet wide being taken at each cut. The ground having been thoroughly prospected in advance, it is possible to avoid barren spots, and numerous pinnacles and ridges of this description will be found distributed over the worked out area.

The excavation is carried on in levels or terraces, a single excavator generally working upon each level. In this way one shovel will be mining the first cut including the necessary surface work, while a second will be taking off the second cut at a level 25 feet below the first, and possibly a third will work at a still lower level. This regularity of working has not been generally observed, and the greater portion of the ore-bearing area has been now gone over by the first cutting, while a considerable area has been second cut, and a smaller area third cut. It is estimated that about three cars of run of mine material will produce one of washed ores.

A partial hand separation takes place at the mine where the largest and purest lumps are picked out, laid aside until sufficient have accumulated and then shipped without further treatment. During the early days only the large lumps were used for smelting in the neighboring furnaces, the finer ore being separated by screening at the mine and left where it fell from the revolving screen or trommel. As a result many of the first cuts now made by the shovel include these old screenings and consequently yield an unusually rich ore product.

The systematic and extensive washing of the ore dates from a comparatively recent period, for in former times it was only where streams were available that the washing could be carried on. These mountain valleys are not well-watered, and not until about twenty-five years ago was it discovered that an abundant supply of water could be secured by sinking so called artesian wells. This discovery gave a new impetus to the mining of these surface ores, and now the country is dotted here, there and everywhere with the old derricks used in driving and operating these wells, the derricks being in many instances the only remaining evidences of the former scene of activity, or of an unsuccessful mining venture.

At the washer the cars are hoisted and lowered by an inclined plane, on which are three tracks, two for the loaded and a third between them for the empties, which are lowered by a tail rope, while the full cars are hoisted by a reversible endless rope, both ropes being worked by engines located in the washer building. At the top the cars run upon revolving dumps, of which there are two, one for each track. These dumps, which turn the cars upside down are necessary on account of the sticky character of the ore, which could not be readily dumped from the end of the car. From the revolving dump the empty cars are dumped off by the loaded and run upon a transfer platform which carries them to the empty track located midway between the loaded tracks and at a slightly lower level. This transfer truck is merely a platform car running upon a depressed track and moved by hand, being so counterbalanced that it will return to its position in line with the loaded track as soon as the empty car has been run off and the truck thus released.

Directly below the two dumps are inclined hoppers from which the ore passes over a grizzly composed of iron bars slightly inclined to the horizontal and placed 5—6 inches apart. At the foot of this grizzly is a platform upon which workmen stand and with large iron hooks prevent clogging of the bars, at the same time drawing the large lumps which will not pass between them onto the platform, where the clay balls are separated from the large lumps of ore, the former being thrown upon one side and carried to the mud bank, while the lumps of ore are thrown into a small car and from that loaded directly into the R. R. car for shipment, together with the lump ore which is separated at the mine as previously mentioned.

The small ore passing through the grizzly bars goes next to a pair of toothed rolls thirty inches in diameter, and 48 inches in length, set 2 inches apart and running 40 revolutions per minute.

A revolving screw washer 23 feet 2 inches in length made with iron arms bolted to an iron axis, receives the crushed material coming from the rolls together with a stream of water. At the end of this first washer or "mixer" as it is sometimes called, are placed three parallel troughs containing screws similar to the first and with their axes parallel to the axis of the mixer, but only 19 feet 2 inches in length. The material from the mixer passes through the first of these parallel troughs, then through a lateral opening in the end into the second trough of the series which it traverses in a direction opposite to that taken in the first, then through another lateral opening located diagonally from the other into the third washer of the series, which is traversed in the the same direction as the first, the washed material from this last screw emptying into a circular trough provided with a perforated bottom through which the muddy water drains, and from this trough the particles of ore and flint rock are raised by an antique revolving bucket elevator and delivered into a double-revolving trommel. This is made up of two concentric punched screens, the inner having circular holes one-half inch in diameter, and the outer oblong slots one-half inch long by one sixteenth broad. Through the trommel axis runs a pipe and from it jets of water play upon the ore as it passes over the screen, while the well-washed ore and rock are delivered by the trommel upon a traveling picking belt 30 feet long and inclined at an angle of 10 degrees, along which stand men and boys who pick the flint and the clay balls from the ore, which then drops over the head of the picking belt into a chute and thence passes directly into the cars for shipment. The refuse flint and clay from the picking belt are thrown aside upon the floor and subsequently shoveled into a small car for transfer to the dirt bank. This car runs upon the same track with the one previously mentioned as carrying away the large clay balls from the first cobbing platform. The foregoing description applies to but one half of the washer, but the other half is an exact duplicate.

The muddy water from the washer runs into a well located outside of the building and across the railroad tracks from the loading chutes. From this well it is raised a height of 25 feet by a bucket elevator, and discharged into a wooden launder which carries it to the settling pond several hundred feet away. These ponds cover an area of 25 acres, which has however been prospected and found to contain no ore, but to be underlaid by a deposit of sand.

Formerly the material was jigged before shipment, but the present owners have not found this to be economical nor necessary, so that the jigging of the ore has been discontinued.

The present output of the washer is 300 tons per day, but it is designed to wash 350 tons, while as much as 425 tons have been washed in a single day. From Scotia the shipment is made over the Lewisburg & Tyrone R. R. to Tyrone, whence it goes over the main line of the Pennsylvania R. R. to the furnaces of the company at Braddock.

Written for THE COLLIERY ENGINEER AND METAL MINER.

ELECTRIC PLANT AT ESSEN MINES.

THE LARGEST ELECTRIC MINING PLANT IN AMERICA.

A Description of the Mining and Haulage Plant at the Essen Mines, at Federal, Pa.

The largest electrical coal mining plant in the world has been in operation during the past summer and fall in the mines of the Essen Coal Co., at Federal, Pa. The magnitude of this plant renders it of especial interest to coal operators. Electrical coal mining plants having a capacity of a few hundred tons of coal a day and employing one or possibly two hundred horse-power have become quite common, and one or more such may be found in almost any coal field of this country. But the Essen mines are equipped to produce by electrical machinery over two thousand tons a day, and the plant installed is capable of furnishing six hundred horse-power.

This power plant is in reality a central station, from which two mines are operated. The mines are both "drifts" into the hillside, the openings being about 1,700 feet apart, and known as Essen mines No. 2 and No. 3.

The power house itself is located close to the mouth of No. 3 mine, as the accompanying map shows. This location was chosen for several reasons; it concentrates the entire plant at No. 3 tipple, which is a quarter of a mile nearer the town of Federal than No. 2. It also makes a simple matter of supplying the boilers with slack coal, since a car load from the tipple has to be pushed but 200 feet to the boiler room. And furthermore, the location puts it equally distant from the point of utilization of the power in the two mines, the workings in No. 3 being much farther from the drift opening than in No. 2.

From the power house a line of three No. 0000 bare copper wires extends to each mine and then down the slope and underground, a distance of 2,000 feet in No. 2 and 4,000 feet in No. 3. In each mine this constitutes the main feeder, and from it current is supplied to the trolley wires and the machine wires, which ramify throughout the workings.

The map, Fig. 1, shows the plan of the wiring for the entire plant. The main feeders in each case extend from the switch board to the points marked by a cross.

Throughout the underground workings the rails are used for the return conductor; they are bonded at the joints and cross-bonded at intervals of 100 feet. All of the main entry track is of 40 lb. steel rail, well laid, and makes an exceptionally good road bed for the locomotives.

Turnouts are provided as shown and the trips are made up at these points in either mine and pulled by the electric locomotives to the main partings, where they are taken by a rope up the inclines to the respective tipples. Mr. Baldwin, the mine superintendent, has shown excellent judgment in making the main partings at the foot of the inclines of very ample capacity. In each mine there is about 1,200 feet of track at this point and this liberal allowance renders unlikely delays from the accumulation of either empties or loads.

The pit cars weigh about 1,200 lbs. each and carry 2,500 lbs. of coal. The locomotives pull trains of from 40 to 50 of these cars, and with this load they run eight miles an hour. Their normal draw-bar pull is 3,500 lbs. at this speed, but in starting a train, or in pulling up a grade or around a curve, they exert a much greater pull, although at a reduced speed. A test was made on one of them at the mines, to determine just what was their maximum pull; a train of 50 loaded cars was started on a reversed curve and a dynamometer registering up to 9,000 lbs. was put between the locomotive and the first car. When the machine was started up the indicator went beyond the extreme end of the scale, indicating a draw bar pull of over 9,000 pounds. The track was, of course, well sanded, but the true secret of this enormous pull will immediately become apparent to any one who is fortunate enough to have the opportunity of personally examining one of the locomotives. The large heavy drive wheels, the soft steel tires, and the single 85 H. P. motor geared to both axles, explain the whole matter. The locomotive weighs ten tons in all and 20% of the entire weight is in the wheels. The two pairs of drivers, moreover, are not built into one rigid truck but each pair is at liberty to follow the track irregularities, regardless of the other pair, this results in keeping all of the four wheels on the track all of the time and is one of the features making possible the 9,000 lb. draw bar pull above referred to. Each locomotive will easily haul out 1,200 tons of coal in 9 hours, pulling it a distance of 4,000 feet.

A striking feature of the locomotives is the head-light. It is in reality a miniature electric search light and consists of a 1,000 candle power arc lamp fitted out with a parabolic reflector. It can be seen down the entry as far as the entry is straight and as a source of light, there is no comparison between it and an oil or incandescent lamp; it is in a class by itself. This strong light is of the utmost importance, since it enables the motorman to see any track obstruction in ample time to bring his train to a standstill before reaching it, even though running at full speed.

The locomotives come out of the mines every night through the manways, which are practically level, and run into the the motor room which is at one end of the power house. Here they are given a supply of sand for the next day and whatever oiling and general cleaning up they may require. The manways are also used by the locomotives when bringing out slate or taking in props and other supplies. Fig. 5 shows a locomotive coming out of No. 3 Mine at the close of a day's work.

The coal at the Essen mines is the "Pittsburg" vein and contains considerable sulphur, especially in the lower parts where the machines cut. This made the mining of the coal by machines a serious problem.

The "Independent" Chain machines, illustrated by Fig. 3, which were put in, have, however, proved entirely capable of the work, notwithstanding the sulphur, and they have made as high as 54 cuts each 3½ feet wide, per shift of 10 hours, from 30 to 40 cuts being an ordinary occurrence. Sixteen of these machines are now in daily use, and, running double shift, are capable of producing 2,400 tons of coal a day from this 5½ ft. seam.

The reason of this machine's success under these most exacting conditions, is found in its general strength. Both in the electric motor and in the mechanical parts there is an ample margin of safety, and this fact reduces the repairs and their attendant delays to a very small item.

The nature of the "feed" on the machines also renders them especially applicable to work in coal containing sulphur or other impurities.

The machine is fed in by a sprocket wheel receiving power from the motor, and working on a sprocket chain which is on the stationary frame. This chain has a very stiff spring at either end, and, therefore, when the cutters strike something unusually hard, this spring is compressed, allowing the machine to stop feeding for a small fraction of a minute, thus permitting several cutters to pass over the obstacle before the machine again advances; whereas if the feed were absolutely positive, each cutter would be compelled to cut as much of the harder substances as of the coal. If the impurity is sulphur, and, therefore, quite impossible to cut, the machine will stop feeding until the spring is entirely compressed, and then with the energy of the spring added to that of the "feed," the cutters are frequently forced behind the obstacle, jerking it out bodily. The practical working of this feature of the machine is evidenced by the large flakes and layers of sulphur band that are frequently pulled out by the chain.

The machines make a cut 4 inches in height and work in rooms approximately 30 feet wide, about nine cuts being necessary to finish up a room. The cut is 5 feet deep, and this makes a total undercut of 150 sq. ft. per room. The machine, in advancing under the coal, travels 5 ft. in three and one-half minutes and backs out in a minute and a half. About 250 rooms are wired in each mine. It is, however, impossible to cut every room, every shift, as the room, after being cut, must be blasted, have the coal loaded out and the gob thrown back before the machine comes in for the next cut. While this work is going on the room wire is entirely disconnected from the entry wire and is, therefore, "dead." At the foot of each entry there is a switch whereby the current may be entirely cut off from the

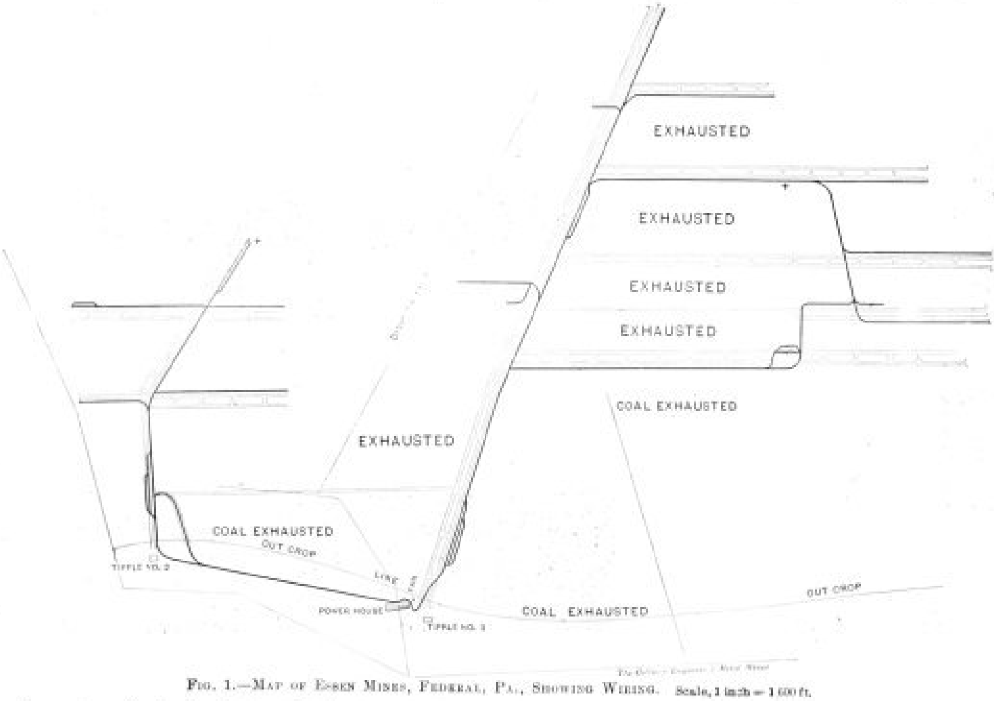


FIG. 1.—MAP OF ESSEN MINES, FEDERAL, PA., SHOWING WIRING. Scale, 1 inch = 1 600 ft.

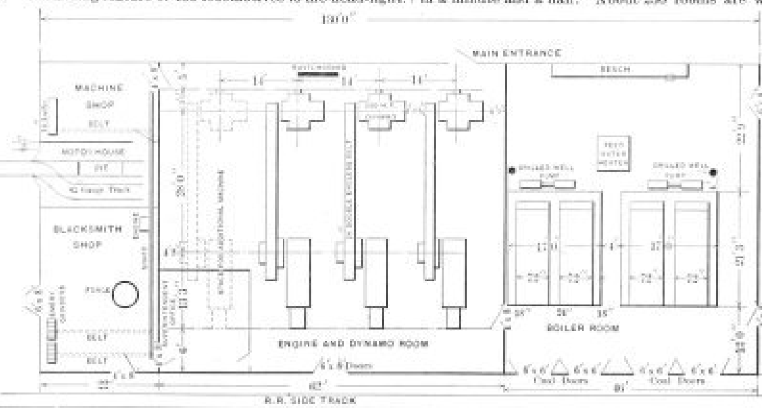


FIG. 2.—PLAN OF POWER PLANT, ESSEN MINES, FEDERAL PA.

entry, and in combination with this switch there is a safety fuse which any abnormal current will melt, thereby opening the circuit and cutting off the current. This arrangement of switch and fuse renders every entry independent of every other entry, and an accident, such as a fall of roof, on one will not interfere with work on any other. At the main parting in each mine there is a large switch, whereby the power may be instantly cut off from the entire mine.

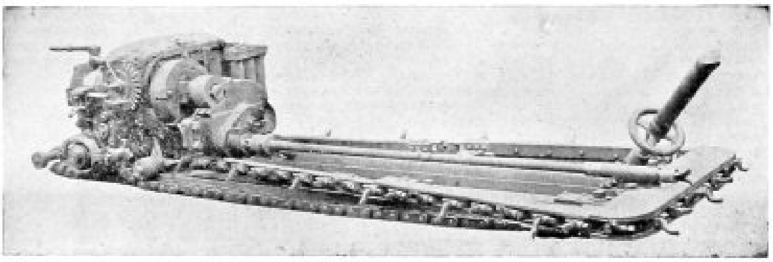


FIG. 3.—"INDEPENDENT" ELECTRIC CHAIN BREAST MINING MACHINE.

FIG. 4.—MINE ARC LAMP.

The main partings are extremely well lighted, the "Independent" mine arc lamp, shown in Fig. 4, being used for the purpose; this is a thousand candle power lamp and burns off the same wires that furnish current to the machines. It is only 12″ high, and may, therefore, be hung from the roof without interfering with work on the entry. The light is the lowest thing on the lamp, and, therefore, all of the shadow is thrown on the roof, giving an unobstructed light on the floor.

The building, illustrated by Fig. 2, which supplies the power for all of this machinery is an iron structure 56 ft. wide by 130 feet long. Forty-six feet of one end are occupied by the boilers. There are four of these grouped in two banks of two boilers each. They are tubular boilers 72″ in diameter and 18 ft. long. In front of them is a space for coal, and behind them the feed-water pump, heater and the injectors are located. There is also bench space, used for pipe fitting. The water for the boilers is taken from two wells drilled for the purpose, in this part of the boiler room.

The middle portion of the power house is occupied by the engine dynamos and switch board. This part of the plant consists of three medium speed 17 x 24 Corliss type Russell automatic cut off engines. The engines run 150 revolutions per minute, and each one is belted directly to a 150 K. W. "Independent" mine type generator. The belts are 24″ wide and the centers of engine and dynamo pulleys are 28 ft. apart.

The three dynamos are slow speed, bi-polar machines, and especially impress one with their extreme solidity and simplicity. They are absolutely free from sparking, even when operating under heavy over loads, and their armature temperature under full load never exceeds 40 degrees Centigrade above the air, while the fields heat up less than 20° Centigrade above the surrounding atmosphere.

The switches, instruments, etc., are mounted on three panels of white Italian marble, shown in Fig. 6, and present a very handsome appearance. The arrangement of the switches is such that any or all of the dynamos may be thrown onto both mines, or either of the mines may be shut off at will. The current to each mine is controlled by an automatic circuit breaker, whereby an accident in one mine will automatically open the circuit there, without interfering with work in the other mine.

Three Weston ammeters and one Weston voltmeter indicate at all times just the amount of power being used on the line.

The normal voltage at the switchboard is 275; the dynamos are over compounded so as to raise this to 300 at full load, and the working voltage underground is from 240 to 250. This combines a perfectly safe current with one that does not necessitate the use of a prohibitory amount of copper, even where the workings are as extensive and as far from the power house as in this case.

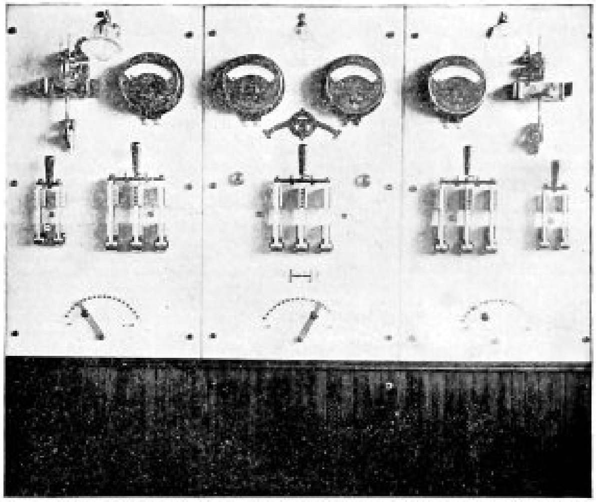


FIG. 6.—SWITCHBOARD FOR DISTRIBUTING 600 ELECTRICAL HORSE POWER AT MINES OF ESSEN COAL CO., FEDERAL, PA.

The cables connecting the dynamos with the switch board have across section of 400,000 circular mils and are three-fourth of an inch in diameter. They pass from the dynamos overhead to the switch board. This method has the very great advantage of keeping the wires where they are in sight and easily accessible and is greatly to be preferred to the altogether too common practice, in small plants of running the cables under the floor where they are out of sight, out of mind and inaccessible.

FIG. 5.—80 H. P. "INDEPENDENT" ELECTRIC LOCOMOTIVE WITH TRAIN OF COAL, AT MINE OF ESSEN COAL CO., FEDERAL, PA.

The engine room is provided with a good brick floor, all of the steam pipes are covered with asbestos, and the whole air of the place is that of a thoroughly first class plant.

The east end of the power house is divided into three rooms, one of these contains a lathe and bench room; one is used for a motor room; and the third is fitted out with forges and emery wheels for dressing up and sharpening cutters.

The plant was first started up in May and soon after starting, a very comprehensive system of keeping track of the work was inaugurated. Each machine runner immediately upon coming out of the mine at night filled out a blank in duplicate, showing the number of cuts made, number of feet of face cut, the number of hours he worked and the nature and cause of delays, if any. The number of his machine was added and the report signed by himself, his helper and pit boss. One of the reports was filed at the mine and the other sent to the Chicago office of the Link-Belt Machinery Co. A photographic reproduction, (Fig. 7) of one of these blanks is shown and will make the whole system very clear. Later, these reports were merged into a general monthly report (see form, Fig. 8.) from which the average results for each machine and each runner were readily obtainable. To this thorough system for keeping track of the work, as well as to the inherent excellence of the machinery, the splendid results of the plant are attributable.

The contract for this, the largest electric mining plant, was let to the Link-Belt Machinery Co. of Chicago after a thorough investigation of all the leading electric mining plants of the country by Mr. Dysart the General Manager and his Superintendent, Mr. Baldwin. That they did not err in their judgement is attested by the fact that the plant was in operation two days ahead of the contract time and every stipulation and guarantee of the manufacturing company regarding the capacity of their machines not only met but surpassed. And the fact that the plant was formally accepted and paid for in full in accordance with the

FIG. 7.—FORM OF DAILY REPORT.

L. B. MACH'Y CO. Mine No. 3 Town Federal State Pa.
"INDEPENDENT" CHAIN MACH. NO. 20 SHIFT day DATE Sept. 2 189 5

		DELAYS AND REPAIRS
No. feet face cut,	166	
Total number cuts,	54	
No. cuts "wide,"	51	
No. cuts "narrow,"	3	
No. moves,	6	
No. hours worked,	10	
Tonnage,		
No. of room,	4-5-7-9-11 13 & Break through	
No. of entry,	23	
Machine runner,	Pat. McCune	
Machine helper,	William Jones	

O.K. Wm McCoy Signed Thos. Miller
Pit Boss

FIG. 8.—FORM OF BLANK FOR MONTHLY REPORT.

L.-B. MACH'Y CO. Town .... State .... Mine ....

Summary Report of "Independent" Chain Machines for Week Ending 189

NAME OF RUNNER	Number of Cuts	Average No. of Cuts	Feet Face Cut	Average No. Ft. per Shift	Hours Paid For	Hours Worked	No. Cuts Wide	No. Cuts Narrow	No. Moves	Avg. Feet Face per Cut	Tonnage
Totals,											
Averages,											

O. K. Signed:

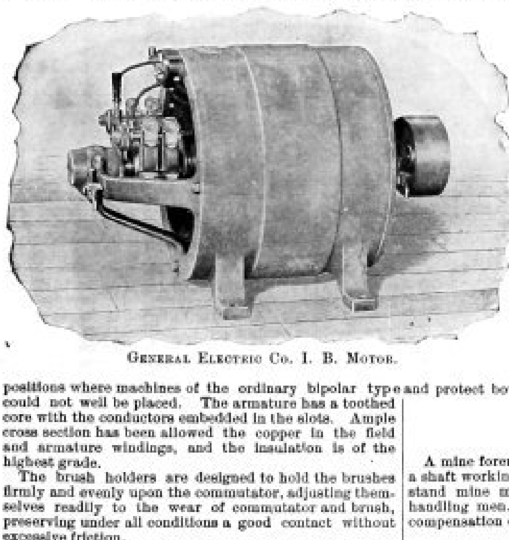
N. B.—1st. Make up this report weekly, attach it to daily report blanks for that week, and mail to Mining Department.
2d. Daily report blanks must by signed by some representative of Coal Company from time first machine starts and all delays and breakages noted thereon.
3d. Furnish Coal Company with copy of this report when requested.

terms of the contract, is evidence that Pickands, Mather & Co, who control the Essen Mines, were satisfied that the plant was all it was represented to be.

Ironclad Generators and Stationary Motors.

The list of slow and moderate speed four pole dynamos and motors of the General Electric Company, has been supplemented by a series of machines adapted to smaller output than is practicable with the four pole type. They are classed under the head I. B. from the fact of having an ironclad bipolar frame, and are built for various outputs—from ¾ to 4½ kilowatts as generators and from 1 to 5 horse-power as motors.

The frames are cylindrical and are supported on short legs. This brings the center of gravity very low and conduces to stability and steadiness when running. The space occupied by the machine is small for its output, and its shape and construction allow of its use in



GENERAL ELECTRIC CO. I. B. MOTOR.

positions where machines of the ordinary bipolar type could not well be placed. The armature has a toothed core with the conductors embedded in the slots. Ample cross section has been allowed the copper in the field and armature windings, and the insulation is of the highest grade.

The brush holders are designed to hold the brushes firmly and evenly upon the commutator, adjusting themselves readily to the wear of commutator and brush, preserving under all conditions a good contact without excessive friction.

The speeds are comparatively low varying from 1,800 to 1,000 revolutions per minute according to the size of the machine.

They are especially adapted to the requirements of small motor service. Their small size, low speed, high efficiency and simplicity of construction render them peculiarly valuable in printing, wood turning and establishments of a similar character, and for the operation of small pumps, ventilating fans, machine tools, etc. A large number of these I. B. motors are already in use.

The generators are successfully used in isolated plants and in cases where a small amount of current economically generated is desired.

To Mine Managers.

Among the new advertisments in this issue of THE COLLIERY ENGINEER AND METAL MINER, are the following.

The Bloomsburg Car Mfg. Co. of Bloomsburg, Pa., manufacturers of freight, mine and dump cars of every class, and also manufacturers of the well known "Bowden" self-oiling mine car wheel. This company has extensive works at Bloomsburg, and has won an enviable reputation for excellency of work, promptness in shipment and reasonable prices. Their circulars and catalogues are of interest to every mine manager.

The well known pump manufacturers, The Geo. F. Blake Mfg. Co., and The Knowles Steam Co., make their debut as advertisers in THE COLLIERY ENGINEER AND METAL MINER in this issue. The use of Knowles and Blake pumps for many years in every mining field on the continent attests their reliability and efficiency. The pump user who does not possess their catalogues should send for them at once. Their is no telling when a new pump of some description from a small boiler feed to a large mine pump for heavy duty is required. When it becomes necessary to order a pump the wise mine manager will at least consult the catalogues of such well known manufacturers even if he has "almost made up his mind to purchase some other make." The immense number of Knowles and Blake pumps in use for many years is the strongest testimonial of their excellence.

Messrs. Wyckoff, Seamans and Benedict, also make their debut in this issue as advertisers. Their specialty is the Remington type-writer. The office of the present that is not equipped with a type-writer of some kind, is the one in which either the amount of business done is exceedingly limited or the cost for clerical work is excessively high. There are more Remington type-writers in use in large railroad and other corporation offices, as well as in the various governmental departments at Washington, than any other. They are well made, convenient and easy to operate, and they are the best manifolding machines we can get for use in our own offices. This latter feature alone is a valuable one in a mining office. Their catalogues are sent free on application, and we advise every mine manager in want of a machine to look into the merits and advantages of the Remington before purchasing any other.

Another new advertiser this month is the Allison Coupon Co. of Indianapolis, Indiana, whose coupon books are described in another column. These books are a decided advantage at mines where stores are run in connection with the mines. They absolutely prevent mistakes in accounts and protect both the operator and miner.

Wanted.

A mine foreman to go to Colorado to take charge of a shaft working 7 feet of bituminous coal. Must understand mine machinery and have had experience in handling men. Address, stating experience, age and compensation expected,

413,
Care THE COLLIERY ENGINEER AND METAL MINER.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for December.

QUES. 193. As we are trying to make our new patent safety lamp the best in use, we cannot be over careful in avoiding the errors that may spring from our own ignorance. Now there were two of the primitive lamps that were furnished with glass chimneys, and one had it set within the gauze cylinder, as in the Stephenson lamp, and the other had the chimney set over and outside of the gauze, as in the Jack lamp, and to make the use or intention of these glass chimneys so clear that we may discover any essential principle in them that should be incorporated in the structure of the new lamp, will you please explain to me four things?

First. What was the use of these glass cylinders in promoting safety?

Second. Did these glass chimneys increase or diminish the light from the lamp?

Third. Did these glass cylinders increase the motive column and make the lamp burn where other lamps would go out?

Fourth. Was the safety of the lamp increased or decreased when by accident the glass cylinder was broken?

QUES. 194. Before commencing to sink we are boring to find the thickness of the seams, and those of the intervening and overlying strata, and the general direction and amount of the dip. We have two good seams, and the top one A, according to the prevailing thicknesses east of us, should be 4.5 feet, and that of B the lower seam 3.75 feet, and in addition we know that the thickness of the rocks between A and B should be 104 feet; but if the excited story of our master borer is to be believed, these thicknesses will be found to be quite different for the following reasons:

At 2 o'clock this morning our house door-bell rang most violently, and running to the stairs I shouted, "Whose there," when a voice replied, "It is me, the master borer from Hardrock," and he continued, "I bring good news, we have cut seam B with the bore tubes at 57 feet instead of 104 feet," and I said "Good, that will save the expense of boring the other 47 feet," but he replied, "That is a trifling consideration, and this is what you should know. The thin intervening rock indicates a thick seam, and instead of 3.75 feet, the B seam will most likely be 6 feet." Now this is good hope if it is not good news, and I will be obliged if you will tell me on what geological facts or principles the master borer founded his opinion. I may say that all the mines east of us are deeper to the A seam than we are.

QUES. 195. Will you calculate for us the quantity of air in cubic feet per minute we will obtain with a 2 inch water gauge. The fan is 30 feet in diameter and runs with an angular velocity of 90 revolutions per minute, the diameter of the central orifice of intake is 12 feet the area of the throat of the fan is 130 square feet the area of the orifice of discharge is 60 square feet and the radial length of the blades is 9 feet.

QUES. 196. We are passing 86,400 cubic feet of air per minute through an airway 10 feet high, 12 feet wide and 3,000 yards long with a water gauge of 3.29 inches, and as we do not now require such a large quantity for this district, we are going to reduce the supply with a regulator and pass instead only 36,000 cubic feet per minute and we will be obliged to you if you will calculate for us the area required in square feet to pass the stated quantity through the regulator. Make the co-efficient for the *vena contracta* .65, and the co-efficient of friction .00000001.

QUES. 197. We have sold a conical heap of coals to three persons A, B and C, and to prevent injustice of any kind we will be obliged for your assistance in furnishing us with the heights at which each purchaser will have obtained his correct weight. For example, the cone is 42 feet high, and the diameter of the base is 90 feet, and as a cubic foot of these broken coals weighs 53 pounds, will you first tell us what is the total weight of the heap, in tons of 2,240 pounds, and as each of these persons have paid for one third of the weight of heap, we have arranged to surround the heap at the height you give us with a platform, so that A can only cut off the top of the cone to get his share, and then we will erect the platform to allow B to obtain his share, and the remainder will be C's share. Now please tell us how high the platform should be set for A's share to cut off a cone, and for B's to cut off a frustum, and leave C his just share as the remaining frustum.

QUES. 198. Why is anthracite coal broken in pieces before it is sent to the market for sale and for use as fuel?

Answers to Questions which Appeared in October and Previous Issues, and for which Prizes Have Been Awarded.

QUES. 174. My Uncle George is a mine superintendent and he asked me to-day if I had given due attention to the study of mine machinery, and steam engines and boilers? and I said oh! yes, I know all about them, and nobody can teach me any more than I know; and he said, "hem," and continued, "Solve me this question and let me have the answer in a few days."

We have a semi-portable hauling engine in the Burdock mine, and it it rather light for the work, and therefore, always runs with full steam. It is 80 horse power, and the highest pressure of the steam at blow-off is 90 pounds on the square inch.

The train has a speed of 10 miles an hour on the level road when the steam pressure falls to 50 pounds on the square inch, and on coming within 850 yards of the shaft the train of cars has to ascend an incline, when the speed reduces and the pressure of the steam in the boilers rises to 90 pounds on the square inch. Now the boiler fire (before the start) is banked up to keep the horse power of the boiler uniform throughout the journey.

The question makes three demands:

1st. Why does the boiler pressure vary?

2nd. What is the gradient of the incline?

3rd. What is the speed of the train on the incline?

I frankly confess, I have made a mistake in bouncing to my uncle George, and I hope you will help me out of the dilemma by answering the questions for me.

ANS. First. The pressure varies because the boiler is making its maximum output of steam when the train of cars is running at 10 miles per hour with a pressure of 50 pounds on the square inch above the pressure of the atmosphere.

Second. The grade of the incline can be found as follows: Let there be 2,240 pounds in a ton, and let the co-efficient of traction for cars, ropes, rollers, engine, etc., be .018 of a ton in pounds; then $2,240 \times .018 = 40.32$ pounds per ton for traction due to level only; and for level and incline it will be 50 : 90 :: 40.32 is to 72.576, that is $\frac{40.32 \times 9}{5} = 72.576$ pounds for traction, and force required to overcome that of gravitation. Therefore the force required to pull every ton up the incline will be $72.576 - 40.32 = 32.256$ pounds. The grade of the incline then is $\frac{2,240}{32.256} = 69.4$, that is an upgrade of 1 in 69.4 feet.

Third. The velocity up the incline will be inversely as the pressure of the steam, because as the volume of the steam reduces, the pressure increases, and as the speed of the engine is directly proportionate to the volume of the steam consumed, $\frac{10 \times 50}{90} = 5\frac{5}{9}$ the velocity of the cars up the incline in miles per hour.

CHAS. E. BOWRON,
Tracy City, Tennessee.

Second, HUGH CAIRNS,
Elco, Washington County, Pa.

QUES. 181. I am about to invent a new miner's safety lamp, and I intend to make the capacity of the tank or oil vessel large enough to supply sufficient vegetable oil for a consumption of 8 cubic inches per day of 10 hours, and as I require your valuable assistance, will you answer me three questions, as follows:

1. What volume of air will be required to supply the necessary oxygen to burn the oil?

2. If only 20 per cent. of the oxygen of the air entering the lamp is consumed, what volume of air is necessary to feed this flame?

3. If, after allowing for the *vena contracta* and the interference of the wires, the available aperturage is in the ratio of .3, and if the velocity of the air on entering is equal to 3 feet per second, how many square inches of gauze covered entrance must I provide for the admission of air?

ANS.—

(1.) Taking $Sp. G$ of the oil at 0.92, the weight of 8 cu. in. would be $\frac{8 \times 0.92 \times 62.4}{1728} = 0.265$ lbs.

Assuming the oil to produce all gas, and if it were rape seed oil, with the formula $(C_{10}\, H_{18}\, O_2)$ 0.265 lbs. of oil would require 3.03 lbs. of air to completely burn it.

From the formula, Wt. Air = 12 × Wt. Carbon + 36 (Wt. Hydrogen — $\frac{1}{8}$ Wt. Oxygen.) In this case, C being $\frac{120 \times 0.265}{170}$; H, $\frac{18 \times 0.265}{170}$ and O, $\frac{32 \times 0.265}{170}$ lbs., as

$$\begin{aligned} 10\,C &= 120, \quad (C = 12) \\ 18\,H &= 18, \quad (H = 1) \\ 2\,O &= 32, \quad (O = 16) \\ C_{10}\, H_{18}\, O_2 &= \overline{170} \end{aligned}$$

3.03 lbs. of air ÷ .0807, Wt. 1 cu. ft. air, = 37.55 cu. ft. Ans.

(2.) It would take $\frac{100}{20} \times 37.55 = 187.75$ cu. ft. Ans.

(3.) With assumption in second question,

$$\frac{187.75 \times 1728}{10 \times 60 \times 60 \times 0.3} = 3 \times 12 \times A, \text{ whence}$$

$A = 0.83$ sq. in. Ans.

CHAS. E. BOWRON,
Tracy City, Tenn.

QUES. 182. We have found a large fault in one of our coal seams, and the cheeks or sides are 6 inches apart, and the interspace or vein is filled with calcite and galena. Our mine foreman says that galena always contains gold and silver, and his statement has so excited me with surprise that I have been trying to extract the metal by raising the ore to a high heat on an open fire, but it all wasted away in white smoke. I will, therefore, be obliged to you if you will tell me what I must do to obtain about seven pounds of the metal, and while you are busy please say what I must do to separate the silver from the lead.

ANS. Cut out a representative sample of the vein stuff and break it up into pieces about the size of hickory nuts and after spreading it out evenly, divide the layer into 4 equal parts and with the part taken, continue breaking it smaller, and dividing it still further and further until it is reduced to about 1 pound or less. Next pulverise it small enough to pass through a sieve of 100 meshes to the square inch. Now, take a crucible and roast and reduce with an oxidizing flame, when the metal will be obtained as a button. We now know the weight of metal per pound of vein stuff tested, and the percentages of lead and gold and silver can be found by burning off the lead with an oxidizing flame when a small button of gold and silver will remain. After this we can tell exactly how much vein stuff would be required to obtain 7 pounds of the metal.

P. H. CARROL,
Vivian, W. Virginia.

Second, H. K. MOBERLY,
West Newton, Pa.

QUES. 183. We have 1,000 acres of a seam of good and clean coking coal, 2 feet, 10 inches thick, and at an average depth from the surface of 600 feet; the roof consists of 30 inches of bad shaley coal, or bone; the mean inclination or dip of the seam is 4° 16′ to the east. How do you think I should work this seam to obtain all the coal, as I can only sink the shafts on the western side of the estate, the eastern side being all under water?

ANS. First drive the main haulage roads straight to the eastern boundry and then take out the coal by longwall retreating. The bad top coal would just stow the gob after it had been brushed to make height. The danger of gob fires would be great with such a roof, but the gob could be kept full of water and altogether this mode of working would, I think, best meet the requirements of the case.

P. H. CARROL,
Vivian, W. Virginia.

Second, GEO. BROWN,
Falls Creek,
Clearfield Co., Pa.

QUES. 184. I am engaged by a powerful syndicate to be the chief of a large staff of prospectors to search for useful minerals in Asiatic Turkey, and my instructions are to confine the work to be done to the valleys of the great rivers, the Euphrates and the Tigris, and the valleys of their tributaries, the reason for the restriction being, that the country is not opened up with railways, and therefore the water-ways are the only routes open for transport. In the North of Asia Minor where the great rivers take their rise the stratified rocks belong to the Cenozoic period, and nearly all the exposed rocks found in the valley of the Levant belong to the Mesozoic period such as those that are found on the east of the Tigris and the west of the Euphrates; and between the great rivers, as west of the Tigris and east of the Euphrates, the rocks are mostly of the Eozoic age, although rocks of later ages are found in patches. Now the great stone records of Babylon and Nineveh are cut on slabs of gypsum taken from their near hand quarries, and I will be obliged if you will give me such information as I require.

First.—We know that salt, coal, lignite, copper, lead, silver, gold, and iron abound within the rocks of the valley of the Levant, then please tell me where to send my men to search for them.

Second.—Tell me briefly what class of tools I ought to give each set of prospectors to find the particular minerals they will be sent in quest of?

ANS. *First.*—To find coal and iron ore, send one set of prospectors to search the rocks in the region east of the Tigris, and another set to search west of the Euphrates. To find salt, send a set of prospectors to examine the regions of the gypsum quarries in the neighborhoods of the cities of Babylon and Nineveh, as the salt rock may be expected to overlie the gypsum beds at the dip of the horizons of the quarries.

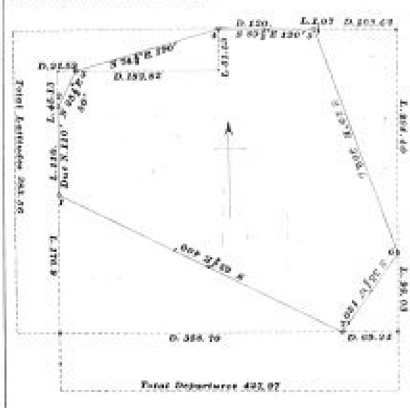
Between the great rivers locate the prospectors for gold, silver, copper, tin, lead, etc.

Second.—Each set of prospectors would require guides and a bodyguard of well armed men, tents, blankets, and cooking utensils. The tools for the metal prospectors should be picks, shovels, hammers, drills, blasting tools, iron ladle, pan, blow-pipe outfit, bellows, hammers, tongs, anvil, carpenters' saws, nails, hammers, etc., microscope, chain, transit instrument, and mapping tools and paper. The prospectors on the Persian side of the Tigris, and those on the Arabian side of the Euphrates, and the set sent into the neighborhoods of Babylon and Nineveh, should have in addition to the tools given to the prospectors sent to operate between the rivers, a complete set of deep bore rods to be worked by hand with a brake staff.

P. H. CARROLL,
Vivian, W. Virginia.

QUES. 185. As I am anxious to obtain a good example of a magnetic survey. Will you give me your notes of one where the figure only has seven sides, also the plot, and the results of the traverse to prove its accuracy?

ANS. In an actual magnetic survey, where the readings of fractions of degrees cannot be made as accurately as on a transit, to obtain better results in the calculations, it is necessary to balance the survey. This is done by distributing the differences of the sums so obtained in the latitudes and departures among the courses in proportion to their lengths.



Station	Bearings.	Distance in feet.	Latitudes.		Departures.	
			North.	South.	East.	West.
1 to 2	Due North.	110.00	110.00	....	0	0
2 to 3	N 25° 30′ E	50.00	45.13	....	21.53	....
3 to 4	N 74° 15′ E	190.00	51.53	....	182.82	....
4 to 5	S 89° 30′ E	120.00	....	1.07	120.	....
5 to 6	S 30° 0 E	302.50	....	284.40	103.62	....
6 to 7	S 35° 15′ W	121.00	....	98.03	....	69.24
7 to 1	N 63° 45′ W	400.00	176.90	....	....	358.70
			383.56	383.50	427.97	427.94

L. A. O. GABANY,
Civil and Mining Engineer,
Brookwood, Ala.

Second, WILLIAM WYLIE,
Civil Engineer,
Washington, Pa.

QUES. 186. We have a pump that forces with two six inch plungers the drainage water of the mine to an elevation of 660 feet. From the commencement, this pump had a heavy "knock" and it was found to occur at the moments when the plungers began their advance on the forcing stroke and it seemed to result from the chambers not being filled close with water during the suction or intake stroke, and the consequence was the knock by the plunger advancing on the force, and the heavy strain that destroyed the packing of the glands and ultimately the "skin" of the plungers that became scored and fluted. Some mechanical engineers declared that the cause of the knock was the softness of the iron plungers that became fluted and leaky, and that the only cure would be found in getting nickel steel or bronze plungers; our engineer, however, thought differently and said the only cure would be found in slacking the glands and drowning them with water. He then fixed cases over the outsides of the glands and filled them with water when the knock was completely cured. Will you then explain to me the cause of the knock and how or by what means it was cured by drowning the glands?

ANS. During the intake stroke the vacuum was neutralized by the entry of air between the sides of the plunger and the leaky gland, consequently the pump chamber was never close filled with water, and, therefore, at the beginning of the forcing stroke, the plunger attained a high speed before it struck the water that had to be suddenly set in motion with a jerk.

The drowning of the gland entirely prevented the entry of air, because a little water entered instead, and thus the pump chamber was always closely filled with water, and, therefore, at the beginning and all through the stroke, the engine had force against a solid column.

HUGH CAIRNS,
Elco, Washington Co., Pa.

Second, CHAS. ED. BOWRON,
Tracy City, Tennessee.

PERSONALS

Mr. T. B. Corey, of Seattle, Washington, resigned his position as mine superintendent of the Oregon Improvement Co. on the first ult., after an incumbency of nearly seven years. Mr. Corey's relations with the company were most cordial, and in his resignation it loses the services of an official who was faithful to its interests under all circumstances.

Mr. A. D. W. Smith, late Assistant Geologist Pennsylvania Geological Survey, has opened an office for the individual practice of his profession as a geologist and engineer at No. 74 Coal Exchange, Wilkesbarre, Pa.

Waste Packed Mine Car Wheels.

The Hockensmith Wheel and Mine Car Co. of Irwin inform us that their works are running full time, and that they are in continual receipt of large orders for their new patent waste packed mine cars wheels. In fact this wheel has met with such favor that the Hockensmith company is arranging to increase its plant so as to enable them to promptly fill all orders. Reports from dozens of users of this wheel show that it is giving universal satisfaction.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical terms and formulae as possible, consistent with clear solution.*

Questions on subjects not directly connected with mining will not be published.

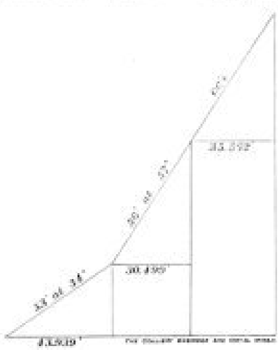
Surveying.

Editor Colliery Engineer and Metal Miner:

SIR:—I submit the following solution to problem propounded by "Tom," Minersville, Pa. in November issue of this journal.

I am working a seam of coal that outcrops on a piece of land which I cannot enter. The horizontal distance of the land line from the high side of the gangway is 110 ft. I have driven a hole up on a pitch of 34° for 53 ft. from the high side of the gangway, and at this point the pitch changed to 57°. I have driven on this last pitch a distance of 56 ft. How much farther can I go on the same pitch before I reach the land line?

ANS. If the horizontal distance is 110′ to line, the horizontal distance of the first 53′ at 34° = 53′ × cosine = 43.938′ + Then the second 56′ × cosine of 57° = 30.499′ + then 30.499′ + 43.939′ = 74.438′, then 110′—



74.438′ = 35.562′ from line on a horizontal distance? Then 35.562′ ÷ .54464 = 66′ nearly. He can drive at work up 66′ feet on the dip of 57° to strike land line.

Yours, etc.,
J. G. LEWIS.

Minersville, Pa.

This question can be solved by forming three separate right angled triangles. And taking a part of the total horizontal distance for the base of each triangle.

Then horizontal distance for first triangle = cos. 34° × 53 = .82904 × 53 = 43.93912 ft.; second triangle, horizontal distance = cos. 57° × 56 = .54464 × 56 = 30.49984 ft. Then the horizontal distance for the third triangle = 110 − (43.93912 + 30.49984) = 35.56104 ft. And as the pitch is the same as the second triangle or 57°, then the distance that the hole can be driven will

$$= \frac{35.56104}{\cos. 57°} = \frac{35.56104}{.54464} = 65.29 + \text{feet farther.}$$

Yours, etc.,
ARCHIE LAFFERTY,
Wampum, Pa.

[We have also received answers similar to one or the other of the above from David P. Thomas, Miner's Mills, Pa.; Alfred Powell, Scranton, Pa.; E. W. Bailey, Rock, W. Va.; Adolph Cook, Houtzdale, Pa.; W. A. Goodspeed, Nelsonville, O.; Geo. H. Winter, Joint, Pa., and 'Carbon," Oskaloosa, Iowa. ED.]

Pumping.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following question in your valuable paper for some of the readers to solve.

In putting in a new line of pipe 640 ft. from steam plant I could not hold pressure for more than twenty minutes at a time for four or five hours. And after that time it was quite easy to hold pressure.

Please state cause of increase and decrease in pressure.

Yours, etc.,
DAVE HOLSTEAD,
Krebs, I. T.

How to Mine.

Editor Colliery Engineer and Metal Miner:

SIR:—I write the following in answer to question asked by "Inquisitive," Mammoth, Kanawha, Co., W. Va. in the November issue.

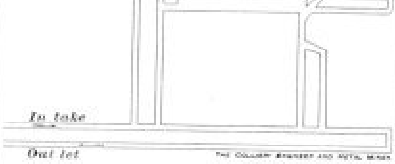
By mining the lower seam first and taking out the pillars, the upper seam would be affected very much. It would be the best to work the upper and lower seam at the same time with the upper seam a little head of the lower; then by taking the pillars out of the lower seam it would not affect the upper seam. I speak from experience, having tried this plan. I worked a 4 foot seam on the stall and pillar system and drew the pillars and then mined a seam which was 5 feet thick, 60 feet higher up the mountain, and I found it to be affected very much where I had drawn the pillars out in the lower seam. Then I tried working the upper seam a little head of the lower seam and I found then by taking the pillars out behind me I was all right.

Yours truly,
GEO. BLEWITT,
Vintondale, Cambria Co., Pa.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—I wish to submit the following drawing of double entry system and request that some of your



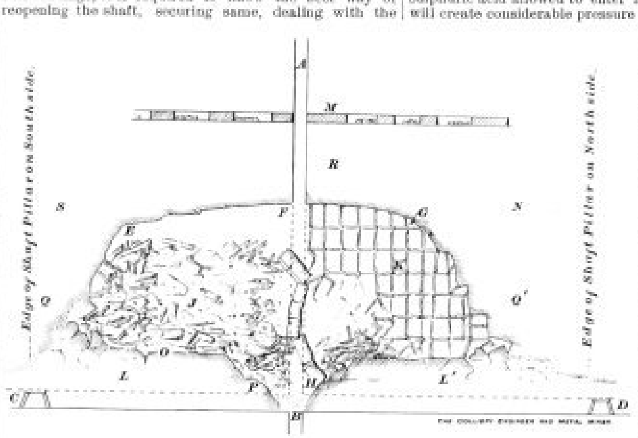
readers give plans for ventilating the same with the least number of doors and without doors.

Yours, etc.,
AJAX.

Reopening a Caved Shaft.

Editor Colliery Engineer and Metal Miner:

SIR:—Given the extent and character of this cave and its surroundings, it is required to know the best way of reopening the shaft, securing same, dealing with the



cave, cleaning up and putting in the permanent shaft and main entries running north and south from it to connect with the interior of mine.

Referring to the section, AB is the bottom 200 ft. or so of the main shaft. This is a rectangular timbered shaft, about 18′x8½′ timbered throughout with 6″x8″ stuff. It is divided into three compartments, 2 cage ways and 1 airway. The shafts longest diameter is in a west and east direction. S and N stand for south and north, B is the sump about 15′ deep, M is a 5′ seam of coal, in which some rooms were worked several years ago and then the seam was abandoned. CB and DB are where the main lyes or roads were before the shaft caved in. The points C and D can be reached to-day by descending the escapement shaft which is intact. There is a small fan on it and from it the workings are kept in repair.

Some 6½ years ago the timbering of the lyes on both sides of foot of shaft broke down and with it the roof caved to about the height O and for 50′ or 60′ inbye from bottom of shaft. These falls were cleaned up and heavily retimbered and no trouble was experienced until a year ago. In Nov. '94 the tower on top burnt, and falling down the shaft, set fire to the timbering about H. This fire went clear up the shaft to the surface and consumed the timbering around top of shaft until the surface for 35′ around it, and to 40′ deep ran in with a rush and smothered the fire below.

In May last the shaft was reopened and made safe down to about F, which is 120′ from the bottom B. The cavity EFG (about 150′ long x 20′ wide) was timbered up, the shaft built or extended downwards through the cave hole as the work proceeded. Slice after slice of debris was removed (hoisted) and by Oct. last timbered securely down to about 35′ from rail level B. LL' shows the quantity of debris not yet taken out, K represents timbering in cave on north side, and south side J was similarly timbered.

On about Oct. 1st, actual fire (red hot rail guides etc.), was met with at O and P. The hose was vigorously applied to it. Doing this seems to have created large quantities of steam, which got up into the timbering and loosened some, as well as the exposed strata (shales chiefly) on that side, the result was this side of the cavity fell in (see JEF) and with it fell the lower 95′ or so of the newly put in shaft. (See F to A). The settling down of the shaft also damaged the timbering K on north side, but which, when last seen was most of it standing in good shape.

The width of the cave as explored and when timbered was reported at from 25′ to 40′ (it got wider as followed downwards). This shaft stands or stood in the middle of a pillar of coal measuring about 350′ N and S x 300′ E and W. The seam is 3½′ thick and worked entirely on the longwall system (Scotch method). The hoisting capacity was 1500 tons of lump coal per day of 10 hours, and when the fire of Nov. '94 occurred this mine was just about at its best having been growing larger and larger since sunk about 12 years ago.

After the fire of Oct. 1st, all was reported cool and quiet in the cave until Oct. 5th, when the fire again and very suddenly broke out about 1 A.M. Water was again turned into top of shaft, but the fire gained on them, until, at 6 A.M. the top of shaft had to be sealed up. Timbers 6″x6″x18′ with 2 layers of 2″ plank on top were used and over these 2′ of puddle and then a layer of sand. The fire in the cavity is so far confined thereto, because there is no sign of it in the mine at C or D, but hot water trickles out on floor at D. Thermometer 200′ deep registers 110° F. This shaft is practically dry and the workings are quite dry. Whether the top of cave F has run up any higher towards R or M is not known, nor whether timbering is intact or not.

Besides the roads CB, and DB, the shaft pillar has been driven through in at least three other places E and W of C B D. Total depth of shaft is 341 ft. from surface to coal.

Yours, etc.,
G. S. W.

Nov. 8, 1895.

Chemistry.

Editor Colliery Engineer and Metal Miner:

SIR:—Will you kindly publish the following questions for answer in your early issues, as it will be a kindness to me.

(1.) If one ounce of bicarbonate of soda and one ounce of sulphuric acid be mixed with 12 ounces of water, the soda and water may be mixed first, then the sulphuric acid allowed to enter in a small stream this will create considerable pressure if confined. What will be the pressure and temperature and how many cubic feet of gas will be generated from these chemicals and what kind of gas will it be. If it will not be convenient to give pressure and temperatures, please give the number of cu. ft. and kind of gas.

(2.) My question in last March issue has never been answered. With your kind permission will repeat it here, as follows: If one pound of carbon from bituminous coal produces 14,500 units of heat, how many atoms of oxygen would be required to form complete combustion under a boiler of moderate draft and at what degree of temperature would the above carbon and oxygen ignite.

Yours, etc.,
WM. M. MORRIS.

Pueblo, Colo., Nov. 22, 1895.

Safety-Lamp Experiment.

Editor Colliery Engineer and Metal Miner:

SIR:—Will some fire-boss who is a reader of your valuable paper give me a correct answer to the following experiment? To test gas with a safety-lamp without a gauze. Removing the gauze from a safety-lamp using soap to close all holes in shield except *one*, I received same indications inside shield as I did when gauze was placed in the lamp. It gave me light but not quite sufficient to work with.

Now explain why the gas did not explode outside the shield, remembering that the mixture was highly explosive.

Yours, etc.,
D. L. AINSLEY.

Mining Tools.

Good tools are essential both inside and outside at mines. Quality is a prime requisite. Tools made of second-class material and in a second-class manner are dear at any price, especially when used at mines. First-class tools can be made to compete in price with second-class goods if the purchaser knows where to buy. The Fulton Tool Works, which were established in 1882, make a specialty of mining tools. Their tools are not pressed but are *strictly hand made*. They are in use in almost every mining region, and their record is first-class. Large purchasers will profit by sending to the Fulton Tool Works of Canal Fulton, Ohio, for catalogues, and small purchasers can be sure of first quality by insisting on their local dealers giving them Fulton Tool Works tools.

Heretofore the deepest sounding of the ocean has been forty-six hundred and forty-five fathoms, near Japan. But the surveying ship *Penguin* sent out by the British government, has found a deeper spot. The sounding wire broke at forty-nine hundred fathoms, when bottom had not been reached. This was exactly south of the Tonga, or Friendly Isles, and almost on the Tropic of Capricorn.—*Ex.*

The Colliery Engineer
AND
METAL MINER.

ESTABLISHED [illegible], INCORPORATED [illegible].

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THE PENNSYLVANIA MINE INSPECTORS' REPORT.

As usual, the report of the Inspectors of Mines of Pennsylvania for 1894 is nearly a year behind time. It has just been issued. We have had the reports of almost every other State for some months and even the report of distant Victoria (Australia) has been in our office for at least two months. Other foreign reports were received still earlier.

Why the report of the Inspectors of Mines of Pennsylvania, which is one the most important of the State publications should be so far behind time is a question that has never been satisfactorily answered by the State Printer.

The report has been received too late for us to analyze the statistics and prepare a summary of them for this issue. Such a summary will appear in our January number.

As usual the work of editing the reports, and the proof reading has been done in a manner that, to say the least, is disheartening to the Inspectors, who have worked hard to make them models of completeness, and is discreditable to the department from which they are issued.

Mr. Edward Roderick, Inspector of the First Anthracite District includes in his report some useful information and hints on pillar robbing, which show that his attention to this subject in 1893, produced good results in 1894, and at the same time points out dangers that can only be avoided by the personal watchfulness and care of the men engaged in the work.

Mr. Patrick Blewitt, of the Second Anthracite District limits his reports to the statistical tables and a brief summary of their contents in his letter of transmittal.

Mr. Hugh McDonald of the Third Anthracite District explains why the number of fatalities per thousand employees is greater in the anthracite regions than in the bituminous mines of Great Britain. His reasons are based on the greater use of explosives in mining the coal, together with the greater disturbance of the overlying strata by blasting in mines, the greater thickness of the coal seams making inspection of the roof less positive, and the difference in the average intelligence of the men employed, due to the influx of workingmen from Southern and Eastern Europe in the past few years. Mr. McDonald's description of the electric machinery at Mt. Lookout colliery is spoiled by having a number of the illustrations mixed up with others in the centre of the Eighth Bituminous District Report.

Mr. G. M. Williams of the Fourth Anthracite District, as usual, presents a report that is not only complete from a statistical point of view, but which contains a vast amount of good practical data and information for the guidance of miners and mine officials. He gives a very complete summary of his investigations at the collieries in his district during the year, and on the subject of ventilation gives the Lehigh & Wilkes-Barre Coal Co. the following commendatory notice:

"This company is the largest coal producer in this district. It operated ten collieries, consisting of seven shafts and five slopes in 1894. All are large collieries having workings of wide extent in several seams. With the exception of one, all are working in deep parts of the coal basin, where explosive gases are evolved in large quantities, requiring immense volumes of air currents and great care in management. They are excellently ventilated and carefully conducted, and liberal provisions are made to insure safety in the event of an accident occurring which would disable the ventilating fans. No standing gas is permitted to remain in any part of the workings, and where such a large volume of air circulates, no satisfactory excuse can be presented by any foreman for the presence of standing gas."

In commenting on the mines of the other large companies, and on those of smaller companies, he states that, in general, they are well ventilated and in safe condition, though he points out one or two minor instances in which changes can be made that will enhance the safety of the men.

The mines in Mr. Williams' district taken as a whole are probably the most gaseous mines on this continent, and when he commends their management for efficient ventilation, it necessarily follows that great attention has been given the subject. A peculiar feature noted in Mr. Williams' report was the discovery that the electric current used on trolley car lines in the neighborhood of collieries can be and is carried into the mines by water pipe or other continuous lines of iron and is a new element of danger that must be guarded against in gaseous mines, owing to the fact that the electric spark will ignite fire-damp.

Mr. John M. Lewis of the Fifth Anthracite District furnishes a very complete statistical report, and includes in his text a report on colliery improvements in his district during the year 1894, and a review of the fatal accidents.

Mr. Wm. Stein of the Sixth Anthracite District, in addition to complete statistics, publishes a large amount of useful information. In speaking of mine accidents he says:—"I herewith assert, without fear of contradiction, that if our workmen would observe the law in the same manner as mine officials do, we would have very few accidents to record. I speak thus from practical experience, and not because I would uphold the assertions of either operators or mine officials at the expense of the character of our employes." He describes in detail Hempel's Apparatus for Quick Determination of Gases, but the description is rendered worthless by the illustrations being inserted in the report of the Eighth Bituminous District. He also describes in detail the fire at Packer No. 5 Colliery and the methods employed in extinguishing it. This is accompanied by a map that is inserted in a pocket in the back cover.

Mr. Edward Brennan of the Seventh Anthracite District presents a very complete statistical report, and describes the fire at Lake Fidler mine and the methods used in extinguishing it. He was more fortunate than his colleague Mr. Stein, as the map and section illustrating his article is in its proper place.

Mr. John Maguire of the Eighth Anthracite District furnishes, besides his complete statistics, an account of the mine fire at the Lehigh Coal and Navigaton Co's. No. 11 Shaft, and detailed descriptions of the extensive improvements made at old and new collieries in his district.

The Inspectors for the Ten Bituminous Districts each present reports that are statistically as near counterparts of those of the anthracite districts as possible. They are also very complete and comprehensive.

In addition to his statistical report, Mr. Henry Louttit of the First Bituminous District notes six prosecutions brought during the year against violators of the mine law in his district. He also reports specifically as to the condition of each mine in his district at the time of his last visit in the year under consideration. His reports on each accident are full and complete.

Mr. Wm. Jenkins, of the Second Bituminous District has a full and complete report, in which he gives a brief description of each mine, with the average quantity of air circulating per minute in each. In commenting on the accidents in his district Mr. Jenkins says:

"The stricter the officials are, the fewer accidents they will have to report. This much I have discovered in my official capacity, that no matter how often the officials visit the working places, they will always find some one working in danger who needs to be warned and severely reprimanded for his carelessness. One of the most fruitful causes of accidents is from falls of slate, and care should be taken in setting posts. The posts should always be set at a right angle with the roof and floor. The cap pieces should always be set across the slips in the slate.

Mr. Thomas K. Adams, of the Third Bituminous District reports all the statistics and the condition of of each mine in a clear and concise manner. In commenting on the causes of accidents Mr. Adams says:

"We cannot emphasize the fact too strongly that miners, no matter how poor they may be, or what their circumstances are their first duty is to have their working places made safe, no matter what time it requires to do it. They must be compelled to use all proper and necessary precautions in protecting their lives and limbs. The performance of this duty must not be left optional with the workingmen. It must be rigidly enforced by men in authority.

Mr. James N. Patterson of the Fourth Bituminous District confines his report closely to statistical information and to the conditions of the mines in his district.

Besides the usual matter found in all the reports, Mr. Chas. Connor of the Fifth Bituminous District, gives his correspondence with Deputy Attorney General Stranahan regarding the correct interpretation of the law as to an applicant for examination as a mine foreman being able to read and write. The opinion of Mr. Stranahan was that such a qualification was necessary. Mr. Connor also gives some interesting and valuable information regarding the working of a Stanley heading machine at the H. C. Frick Coke Co's Leisenring No. 2 mine. He also dwells on the carelessness of workmen, and says: "Neither legislation nor instruction will prevent accidents unless the persons employed in or about the mine will exercise common sense and take precautions to protect themselves." He also describes the draining of the gas from about ten acres of "gob" at the Oliver mine, by a bore-hole from the surface.

Mr. J. T. Evans of the Sixth Bituminous District, in his report, emphasizes the remarks of his colleagues on the lack of care on the part of workmen as a frequent cause of accidents. He notes four very important changes in opening and conducting mines at the present time that give excellent results as to economy, safety and sanitary conditions. They are (1) Haulage by machinery; (2) The method of drainage by which the water flows out through the main airway driven parallel and to the dip of the hauling roads; (3) The driving of wider headings; (4) The drawing back of pillars as soon as the room reaches its limit of length.

Mr. James Blick of the Seventh Bituminous District confines his report to the statistical tables, reports on the condition of each mine, with improvements made during the year and detailed accounts of all fatal accidents. He announces a decided improvement in the sanitary conditions of the mines, which he ascribes as due to the beneficent influences of the mine law of 1893.

The report of the Eighth Bituminous District is made jointly by Messrs. J. T. Evans, and R. Hampson. The district was under the supervision of the late D. H. Thomas, who died Jan. 27, 1895, and Messrs. Evans and Hampson of the adjoining district prepared the report from Mr. Thomas' notes. The report is complete with the exception of the fact that Messrs. Evans and Hampson did not have the data from which to report on the condition of each mine. In connection with this report some views of electrical machinery at Mt. Lookout colliery in the Third Anthracite District, and views of the Hempel apparatus described by the inspector of the Sixth Anthracite District are mixed up with some views of electrical machinery, etc., at Smoke Run mine, in the Eighth Bituminous District. There is, however, not a line descriptive of the latter views in the text, and we are only able to locate them by our knowledge of the plant.

Mr. Bernard Callaghan of the Ninth Bituminous District confines his report to statistical tables and descriptions of the condition of each mine, and of each fatal accident. He also ascribes a large proportion of accidents as due to carelessness.

Mr. Roger Hampson of the Tenth Bituminous District, also, confines his report to statistics, descriptions of the condition of each mine, and a statement of how each accident occurred.

Taken as a whole the volume shows careful consistent work on the part of the Inspectors, and gross carelessness or ignorance on the part of the compilers, editors and proof-readers.

USE OF EXPLOSIVES IN MINES.

As a result of the great study and patient researches into the causes of accidents in mines, special rules and improvements in the mine laws have recently been made in many European mining districts. Among the more recent of these special rules are those promulgated for the Breslau (Prussia) Mine Inspection District. These regulations apply to the use of explosives, and they are very complete.

In the case of fiery mines the rules provide that blasting, when not entirely forbidden, must not be carried on at any points in the mine where the presence of fire-damp may be detected by the safety lamp. This prohibition also extends to all working places in the same division of the mine which are closely connected with working places in which fire-damp has been found, or which receive their air via working places in which fire-damp has been found. This prohibition remains in force until the underground manager, or foreman, has satisfied himself that the working places in question, and those connected with them in the manner above described, are entirely free from fire-damp.

Even if fire-damp be not present, blasting with black powder, or other explosive, is prohibited in working places in which coal dust, known by experience to be dangerous, may have accumulated. In all cases immediately before firing a shot, a careful examination must be made with a safety lamp to prove that there are no accumulations of fire-damp within a distance of 20 metres (66 ft.) from the shot.

In regard to the general use of explosives the rules provide that where sufficient protection from the effects of the blast is not afforded by the workings, special places of refuge must be provided. In the case of missed shots the men are prohibited from returning to the working face for a period of at least ten minutes, and then they may approach it only on permission of the most experienced man in the party. Shot holes charged at the same time must be fired simultaneously, and the *boring* out of shots that have missed fire is prohibited. Shots that have missed fire, and the tamping on them, may, however, be drawn, if copper or soft brass tools are used. At the changes of shifts, the most experienced man must either satisfy himself that missed shots have been rendered harmless, or point them out to the most experienced hand in the shift relieving his gang.

After shots have been fired in a working place, the men are prohibited from entering it until after the most experienced man in the party has satified h mself that a sufficient quantity of air is entering the place to remove the smoke and permit work to be carried on without danger.

In case blasting powder is used, it must invariably be put up in cartridges made with well sealed paper, or other substance that does not give off sparks, and, if it should be necessary to change a cartridge in any manner, such change must be effected at a safe distance from the stock of explosives and the other men. As an additional precaution, the mining lamp must be suspended at a distance from the cartridge so that all danger of fire from it is prevented. The use of iron blasting needles, and of oiled paper or straws filled with powder for squibs is strictly prohibited.

Special rules regarding the care and use of high explosives provide that cartridges containing nitro-glycerine must be thawed, with great care and precaution, before being given out, and afterwards they must be carefully protected from a degree of cold sufficient to refreeze them. Under no circumstances are such cartridges to be brought near a fire, a stove, a steam pipe or any place or substance hotter than a hand can bear. All changes in cartridges of high explosives must be made by the most experienced man in the party using them, who must also make up the cartridges, if they have not already been made up by a man specially appointed for this work. The charging of holes with high explosives must be performed by the "shot-master," or most experienced miner, and the tamping and firing must be done either by the latter or specially deputed miners. The insertion of the fuse, detonator or other igniter in a cartridge must only be done immediately before the cartridge is used. Shots, when high explosives are used, may be tamped with either sand or water.

TECHNICAL EDUCATION.

Technical education in its truest sense means a knowledge of proven principles combined with experience. Such a combination fits a man to direct and lead others in the industry in which he has educated himself. A man a may hold an official position through what is known as "practical experience" but in such a case his "practical experience" has made him familiar with more or less theory. He has learned from observation that certain causes produce certain effects, and this knowledge is "theory."

The practical man who adds to his own experience a knowledge of the experience of others broadens his usefulness and ability in direct proportion to the amount of knowledge of other men's experience he acquires.

A few years ago it was a difficult matter for a workingman to acquire a knowledge of his trade or avocation. While there are text-books, many of a high order of merit, they present technical subjects in a way that makes a fair knowledge of mathematics and physics necessary in the student who attempts to study them. As a rule, the ordinary working man, whose education is limited, either cannot understand the principles and formulæ at all, or he only partially understands them and misapplies them.

There have been a few men, who despite all obstacles, have educated themselves and risen to eminence in the engineering profession. Thousands of others have been successful in a lesser degree through following their examples. These men would have been leaders in every sense had they had such opportunities to secure a technical education, in their early manhood as are now open to American workingmen of all classes. The systematic plan of study, which starts at the beginning of each branch and provides personal assistance and help for each student of The International Correspondence Schools, affords every workingman in America a chance to rise above his present station. A better education than was obtained by the self-educated man by years of application and hard study can now be acquired in as many months by the correspondence system provided the student applies himself.

The International Correspondence Schools are specially designed to educate practical workingmen in mining, mechanics, electricity, architecture, sanitary engineering, civil engineering, etc. Every department is under the supervision of educated and experienced men in the trades or professions taught. They have now enrolled nearly 10,000 students in all parts of the world, and many of them have, through the education gained in these schools materially improved their financial conditions. Full particulars of the schools and an outline of the courses of study are sent free to any person writing for them, and stating what branch he wishes to be educated in. A postal card containing the request addressed The International Correspondence Schools, Scranton, Pa., is all that is necessary.

BOOK REVIEW.

Iowa Geological Survey, Vol. IV, Annual Report for 1894.—This is the Third Annual Report or Prof. Sam'l Calvin, State Geologist. It contains an exhaustive and finely illustrated report on the geology of Allamakee county, by Prof. Calvin, and similar reports on the geology of Linn county, by William Harmon Norton; on Van Buren county, by C. H. Gordon; on Keokuk county, by H. Foster Bain; on Mahaska county, also by Mr. Bain; and on Montgomery county, by Elston Holmes Lonsdale. The report makes a handsome octavo volume of 450 pages, well supplied with maps, cross sections, etc. The book as a whole is too voluminous interesting and instructive to be described in the space at our disposal. It should have a place in every reference library and in the library of every man interested in American geology.

Mining Notes and Formulae.—By William Williamson, Certificated Colliery Manager and Science Teacher; Teacher of Mining and Applied Mechanics in Hamilton, Fife and Midlothian Classes. Second Edition. Published at Hamilton, Scotland by W. Naismith, and sold in America by The Technical Supply Co., Scranton, Pa. This is a revision of Mr. Williamson's first edition, and numerous additions have been made to the original work. Examples illustrating the principal formulae are also given and worked out to show how the formulæ are applied. It is an excellent text-book on coal mining and is well worth the $1.25 charged for it.

Economic Mining, "A Practical Handbook for the Miner, the Metallurgist, and the Merchant," is the title of an octavo volume of 650 pages, by C. G. Warnford Lock and published by Messrs. E. and F. N. Spon, of London and Spon and Chamberlain of 12 Cortlandt St., New York. Bound in cloth, price $5.00. This work is the production of an educated mine manager whose previous reputation as a writer on mining subjects is in itself a guarantee of quality. It deals with the subject as comprehensively and practically as it is possible in a closely printed volume of its size. Matter having only an academic or historic interest is excluded from this book. This affords space in which to deal with just those points which, while not of a strictly scientific value, are of prime importance from an economic standpoint. In briefly describing the features of the work we cannot do better than adopt the author's own language. "Accepting the beds, and lodes, and veins as accomplished facts, this book endeavors to describe in plain language and a practical aim how these deposits may be best worked under the various conditions encountered, and how the valuable portion of their contents can most cheaply and effectively be separated and prepared as marketable commodities." It is profusely and well illustrated.

Hand-Book for Mining Students and Colliery Managers.—Part I., published by the "Science and Art of Mining," Wigan, England. The small pamphlet before us contains four sections. Section "A" treats of elementary geology on the question and answer principle; Section "B" treats on surveying; "C" on lighting of mines, and "D" on the Coal Mines Regulation Act, by the same method. Price six pence (13 cents) or by mail seven pence (14 cents). While the work is more especially designed for British readers, and a large portion of it is applicable only to British mines, it deserves great commendation for its clearness and completeness, when its size is considered. Those portions applicable to mines in general are of so much interest that the mining student in any part of the world will find them of interest and value.

The Production of Coal in 1894.—By Edward Wheeler Parker. A extract from the sixteenth annual report of the Director of the United States Geological Survey. Issued from the Government Printing Office, Washington. This is a pamphlet of 224 octavo pages and contains in great detail the statistics and trade reviews of the various States and Territories, together with a mass of other interesting matter descriptive of the coal fields.

Report of the Inspector of Mines of Kentucky, 1894.—By Messrs. C. J. Norwood, Chief Inspector, and W. U. Grider, Assistant. This is the eleventh annual inspectors' report for Kentucky, and is worthy of special notice as the best and most complete thus far issued by that State. Messrs. Norwood and Grider have taken great pains to make this report a model one. It is a large octavo volume of over 200 pages, divided into twelve chapters, as follows:

I, Preliminary; II, General Conditions of the Mines, etc.; III, Statistical Information; IV, Accidents; V, Strikes; VI, List of Commercial Mines; VII, New and Other Mines; VIII, Notes on the mines; IX, An excellent and timely article on Mine Maps, by Mr. B. W. Robinson of Earlington, Ky., Mining Engineer of the St. Bernard Coal Co.; X, Brief Account of Kentucky's Natural Wealth; XI, Correlation of Kentucky Coals with those of Big Stone Gap, by Mr. J. M Hodge of Big Stone Gap, Va.; XII, Laws Relating to Mining, etc.

Geology of Cripple Creek, Colorado.—By Arthur Lakes, late Professor of Geology, State School of Mines, Golden, Colo. Published by the Chain and Hardy Co., Denver, Colo. This is a pamphlet of 32 pages, descriptive of the famous Cripple Creek gold mining region and its ore deposits. It is illustrated by a geological map of the region and 8 smaller special illustrations. The only adverse criticism we can give the work is to say that it is too good to be issued in pamphlet form. It should have been bound substantially in cloth, so as to ensure its preservation. While interesting reading, it is more than an essay to be once read and then discarded. Every man who reads it will want to preserve it for future reference and use. To do this with a small paper covered pamphlet is not always practicable.

Chemical Technology, Vol. II, Lighting, edited by Charles Edward Groves, F. R. S., editor of *The Journal of The Chemical Society* and William Thorp, B. Sc. Cloth, octavo, 400 pages, illustrated. Price $4.00. Published by P. Blakiston, Son & Co., Phila. This is a work that embraces five distinct heads as follows:—I, Fats and Oils, by W. Y. Dent; II, Stearine Industry, by J. McArthur; III, Candle Manufacture, by L. Field and F. A. Field; IV, The Petroleum Industry and Lamps, by Boverton Redwood; V, Miners' Safety Lamps, by B. Redwood and D. A. Louis. The work is a very comprehensive one, and is of special value to every man interested in the production and sale of illuminants, of appliances for lighting, and to those who are large purchasers or consumers of illuminants and illuminating appliances of any description.

Vitrified Paving Brick. Prof. H. A. Wheeler who has made a specialty of the study of clays, has given the results of his investigations in a pamphlet entitled "Vitrified Paving Brick"; T. A. Randall & Co., Indianapolis, publishers.

The book commences with a brief history of the use of brick as a paving in Continental Europe, and its first introduction into the United States.

The defects of the paving brick first used in this country, largely due to a lack of knowledge of proper materials and processes, are clearly stated and the best up-to-date methods of its manufacture are described in full, making the book of decided value to persons interested in the use or manufacture of paving brick.

The physical properties of paving brick are fully described and chemical analyses, deduced from a large number of reliable tests, are given in detail.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

Fire Damp at High Pressure.—The following translation from the French is copied from the *Colliery Guardian*:

According to Gruner's classification, the 13th seam worked in the Saint-Etienne Colliery belongs to the lower group of the Saint-Etienne basin, its thickness varying in the Treuil district between 4 and 5 metres. This seam is cut at the level of 125 m. below sea level by the Puits du Treuil No. 2, which forms the downcast shaft in this field of working, while the Puits de la Pompe (supplied with a Rateau fan of 2·8 m., (9 ft.) diameter), which strikes it at the level of—95 m., at present forms the upcast shaft and will eventually serve for letting down gob material. The seam is overlain by a small stratum of schistose coal, called *crue*, 1·3 m. (4 ft. 4 in.) thick, and, as a rule, unworkable, from which it is separated by a rock band, called by the miners *carreau*, about 20 cm. (8 in.) thick.

The preparatory headings were driven in this thin seam, between the upcast and downcast shafts; and two inclines, connected every 20 m., constituted the first airways, in forming which nothing occurred worthy of notice. Owing to the necessity of protecting the two shafts against the thrust of the measures, due to taking out the coal, a *massif d'arretsion*, about 100 m. wide, was left round them, beyond which large forward stalls are driven right and left. Levels were put out from the inclines on either side simultaneously, following the roof of the group, while taking out the whole of the thin seam, but a portion only of the thick. It was proposed in this way to pass rapidly across the protecting mass and reconstitute beyond it, by forward and descending headings, the airways necessary for the working. In the eastern district two levels were being driven ventilated by a pure air current, of sufficient intensity to dilute the fire-damp, furnished in the ordinary way by this double advance, when on the 18th of July, 1893, at about 1 P. M. occured the first of the three outbursts of gas which followed in close succession.

Outburst A.—The "governor" of the pit who was behind two interlocked doors, all of a sudden heard a loud noise like the rolling of trams, and he immediately ran in its direction, but when he found his lamp extinguished, he rushed to the face. There he found that, without further preliminary warning than a cracking, caused by the fracture of the rock band which separates the thick from the thin seam, about 20 tons of very small coal had been shot forward into a heap in the level for a length of 3 m., in no way destroying the timber frames for supporting the roof, but giving rise to a considerable outburst of gas which lasted about twenty-five minutes. The lamps were extinguished of the nine men occupying various positions in the course of this vitiated air-current, but they were all able to reach fresh air in safety. The intensity of the current which effectually swept the faces of the working-place where the outburst occurred was 2½ cubic metres per second; and its gas content, found by analysis and daily observations with the Chesneau *grisoumetre* did not exceed three thousandths on the days preceding the outburst while on the day itself the maximum was 8 thousandths, and on the following day the content again fell to three thousandths.

The coal shot forward came entirely from the small upper seam, the compact roof of which had not yielded in any part; and no pocket was found, only a separation extending over a few centimeters between the coal and the overlying rock. When the heading was again pushed forward, it revealed, a few metres ahead of the point where the outburst occurred, the schistose and disturbed nature of the thin seam, which had evidently yielded to a strong internal thrust. After this incident, which no available means could have foretold, No. 2 working-place was stopped, the return preparatory ways were isolated and the intensity of the air-current was increased. Ultimately the heading was driven to its destined limit without further incident.

Outburst B.—Two months later, during the night between the 29th and 30th of September, a sudden, outburst occurred in forward heading No. 2, which was being put out towards the east. The same phenomena as in the last case were repeated—the throwing forward of coal greatly heated, also detached from the thin seam overlying the thirteenth, the absence of dislocation in the walls and roof, and a violent thrust which threw down 20 tons of small and friable coal. This working was ventilated by a current of fresh air coming directly from the shaft and only passing the men engaged in the advance. The useful volume of air at the face was 4½ cubic metres per second; and the duration of the outburst, as compared with an equal quantity of coal got, was only ten minutes instead of twenty-five. The lamps of only the three men in the working place went out, while in the former case the lamps of all the men passed by the current were extinguished. In consequence of this fresh manifestation, the speed of the fan was increased so as to augment the intensity of the current for ventilating the preparatory workings still to be driven, the useful volume of air, reaching the end of the tight partition that divided the level longitudinally, being thus increased from 4½ to nearly 7½ cubic metres.

Outburst C.—About half-past eight in the morning of the 18th of October a fresh outburst occurred in the same working place; and the enormous volume of air circulating through the level was insufficient to entirely purify the atmosphere contaminated by the gas. Three men were working at the face, two of them being in the fresh-air compartment, and the third, who alone had his lamp put out, in the return compartment. The thrust only brought down 2 or 3 tons of coal from the thin seam.

Seeing that the pressure of gas in the strata was the cause not only of the outbursts of gas but the thrusts of coal and rock, steps were taken to find the pressures of the confined gas.

Pressure Gauges.—For ascertaining the pressures, three types of gauges, a water, a mercury and an ordinary pressure-gauge were used, according to the amount of pressure to be measured. The two former were firmly fixed in light wood cases, provided with a movable shutter for protecting them from the shocks to which they would be exposed without this precaution. The ordinary pressure-gauge will measure a pressure up to 50 kilogs. per square centimetre (711 lb. per square inch), each division corresponding with 50 grammes per square centimetre.

Gauging of the volumes was effected by a gas-meter with five dials, registering from litres to tens of cubic metres, enclosed in a wood case provided with handles for permitting its being carried easily in the workings, and also for protecting it from shocks and dust.

Tamping.—The annular space between the iron pipe and the sides of the hole was tamped by a special tool, consisting of an annular metal disc 6 cm. (2⅜ in.) in outside diameter and half that dimension in inside diameter, to which are permanently fixed three iron rods connected at the other end and welded together so as to form a handle. The metal disc, guided by the pipe along which it slides, drives the tamping before it, the latter consisting of clay, slightly damped and rendered sufficiently plastic to adapt itself readily to the sides of the hole. The elaborate tamping used by Mr. Lindsay Wood was not adopted—first, because such high pressures were never encountered as in his case; and, second, because the numerous daily tests made did not permit of such minute precautions. The clay was, however, found quite satisfactory, and it was rare that leaks occurred.

Extent and Results of the Tests.—The distinction between ascertaining the pressure of fire-damp in the coal of the large working places, and in that of the compact coal in the levels or parts of the stalls near them, is equivalent to the consideration of two cases—viz., that in which the face is very large, and that in which it is limited. From the 1st of January, when borings in the face were made regularly, 135 holes were bored from 1 m. to 7 m. deep, the maximum pressures being taken every metre. The observations as to volume, however, were only made from the 25th of May.

In order to facilitate comparison of the results and permit deductions to be drawn from them, the author formed diagrams for each series of observations in the stalls and levels, representing, for the most characteristic types, the leading particulars, such as, (1), the increase of pressure and volume with the depth of hole; (2), the variation of these volumes with the lapse of time; and (3), the progress of the pressure, at a given depth, in a function of the lapse of time, etc., referred to under their separate heads:

Conclusions.—The following are the conclusions arrived at by the author from his observations:

1. The phenomenon of high tension occurs whenever the coal, owing to exceptional compactness, cleaves with difficulty when being taken out, and is especially to be feared in preparatory headings.

2. As a rule, in the large working places of the thirteenth seam, the tension of fire-damp enclosed in a prism of coal 3 m. deep is slight, and generally the mass cleaves sufficiently to this depth for the gas to escape by the numerous channels formed by the spaces caused by a partial *foisonnement* or swelling.

3. The pressure and the volume increase with the depth, according to a variable law depending upon the compactness of the coal.

4. The distribution of the tensions is highly irregular, and the permeability of the coal very variable.

5. For equal pressures observed, the ultimate tension is attained after a very variable duration, which is a function of the gaseous volume escaping from the sides of the hole and of the permeability.

6. The operation of boring pure and simple, regarded as means for taking off the gas, is but slightly efficacious; and, other things being equal, a hole left to itself will show a constant pressure of gas for a long period.

Detonators for Shot Firing.—The experiments of Abel and Trauzl have established the following conclusions:

1. Nitro-glycerine, which can bear exposure for a considerable time to a heat of 193 degs. Cent. without igniting, can be immediately exploded by a cap containing 0.2 gramme of fulminate of mercury.

2. Soft dynamite requires the same amount (0.2 gramme) of this detonator for its explosion.

3. Frozen dynamite cannot be exploded by a cap containing 1 gramme of fulminate.

4. Loose guncotton, in flakes or spun into yarn, which ignites at 150 degs. Cent., requires a much larger detonating cap to produce explosions than suffices for compressed gun-cotton.

5. The last-named can be fired by the aid of 1 gramme of detonator, but weaker caps only pulverize and destroy the cotton.

6. Web-guncotton—containing 100 per cent. of water—is the least dangerous of all ordinary explosives, requiring a powerful initial impulse to cause its explosion.

7. Gunpowder is exploded much more briskly by the aid of detonators than by ordinary means of ignition, other circumstances being equal.

8. The effective power of a cap is dependent on the strength of the case containing the detonator.

These experimental data show that each explosive requires, for the production of its maximum effect, a fixed initial impulse which must be produced in practice by regulating the strength of the detonating cap.

The small detonating charge found by Nobel to be reliably sufficient for the explosion of ordinary kieselguhr-dynamite was 0.3 grammes of fulminate of mercury. These caps were made of copper and were of such a length as to permit the detonator being completely inserted in the cartridge, without, however, allowing the safety fuse, by which the detonator was fired, to come into contact with the explosive. This was necessary in order to prevent ignition of the dynamite from the fuse, which would have only resulted in the imperfect combustion, without explosion, of the material, and in the subsequent production of irrespirable gas, a circumstance to be especially avoided in gassy mines and confined spaces.

Such caps were not sufficiently powerful for the ignition of frozen dynamite owing to the greater amount of heat required in this latter case, and attempts were made to employ mixtures of nitro glycerine, nitre, wood pulp, resin, soda and kieselguhr as igniting cartridges, but unsuccessfully, since these could not even be exploded themselves by 0.6 grammes of fulminate in caps, and for a long time miners had to content themselves with warming the frozen dynamite before use. The military authorities in Germany conducted numerous experiments during several years with the object of obtaining detonating cartridges strong enough to explode the (army) mining ammunition of frozen dynamite in all seasons, with the result that Trauzl's preparation, consisting of 75 per cent. nitroglycerine and 25 per cent. gun-cotton, was accounted the best of its kind. The 1-gramme detonator cap giving equal results was adapted for the German army, but the firms entrusted with its manufacture declined to continue the supply on account of the danger to life and plant incurred in the process of pressing the fulminate into the caps. However, in the following year the introduction of new compound dynamites containing cellulose and gelatine necessitated the manufacture of 3-gramme detonators, although the material employed for army purposes was explosible by detonators of lower strength (2 grammes).

In 1887, there being no longer any doubt that the strength of the initial impulse influenced in the highest degree the effective power of an explosive, the manufacture of powerful detonators became more general, and the following eight sizes were in current use:

1.	2.	3.	4.	5.	6.	7.	8.
0.300	0.440	0.540	0.650	0.800	1.	1.500	2.000

grammes fulminate, stronger ones being made if required, but the effects of the caps produced by different manufacturers were not the same, since each used the casing he considered best, notwithstanding that Abel's researches had revealed the important influence of the casing on the power of the cap. For instance, he found that whereas a 1.3 to 2 grammes detonator encased in a thin wooden box or paper wrapper was required to explode loose cotton wool, the same effect could be obtained by a 0.32 gramme cap in a thin metal sheath, and the German military committee ascertained that the electric fuse gave with brass tube caps, charged with 0.7 gramme of fulminate, an effect equal to that from 1-gramme detonators in simple copper caps.

In storing the caps for use it is advisable to dry them in a closed room for at least forty-eight hours at about 20 degs. Cent., taking all due precautions to prevent explosion, and to then enclose them in cases tightly closed by binding the edge of the cover round with an indiarubber band. Dry caps only should be used, and it is well to subject them to another drying with the cover off the box, so as to reduce to a minimum the chance of miss-fires.

In case blasting holes have to be left some time before firing, the detonators may be kept intact from moisture by surrounding the junction of the cap and fuse with a ring of wax or waterproof paste. It may be remarked that detonating caps may suffer considerable alteration of shape without exploding, and that danger of such a mishap is only to be dreaded when cutting-pliers are used to squeeze the caps, since in that event there is danger of the cap casing being cut through, whereby the fulminate may be compressed by the pliers sufficiently to cause explosion. It is therefore advisable to use only flat pliers for this purpose.

It is especially important in gassy mines to ensure that the detonators employed are able to impart to the blasting charge a sufficient initial impulse to produce explosion. Otherwise, as in cases mentioned by the author, the cap and charge only flare up, and may give rise to an explosion of the gas, doing an immense amount of damage which could have been avoided with a little precaution. The amount of initial impulse required by every new explosive, and the most suitable detonator to give the desired result, should be experimentally determined before blasting is commenced. Only such caps as have the fulminate protected from the influence of the weather, shocks, &c., should be employed, and these ought always to be maintained and used in a dry condition, protected by the application of some waterproofing material at the junction with the fuse whenever used in damp or wet situations.

By adopting these precautions as supplementary to the others practised when blasting in gassy mines, the danger of explosion may be minimized, but to disregard them is inexcusable, in view of the danger to the miners such neglect might produce.

New Regulations as to Mine Explosives in Germany.—The following is a summary of new regulations as to mine explosives, that came into operation on the 1st May, in the Dortmund district of Germany:

General Provisions.—By explosives in the present regulations must be understood all the substances mentioned in section 2 of the Ministerial Ordinance of 19th October 1893, especially blasting powder and saltpetre; dynamite guhr, explosive gelatine and dynamite gelatine; carbonite and other nitro-glycerine compounds; guncotton; securite, roburite, dahmenite, westphalite, and similar compounds; and also detonators. The explosives and igniters required for mine working, except firing tubes, can only be procured by the mine owner or on his account by his representative, and the explosives mentioned in the above named ordinance can only be obtained with the written permission of the competent authority, at the works of the manufacturer or at the places of sale authorized, and inspected by the police, and in the prescribed packing. Besides the underground manager, only the officials and overmen appointed by him, whose names must be entered in the mine journal and posted up permanently, are authorized to receive supplies of explosives, to distribute them to the men and receive back those not used, or to rearrange them if necessary. Only those persons appointed for the purpose by the underground manager may be employed in the transport, storage, distribution and handling of explosives inside the magazines, where flint and steel, naked lights and smoking are expressly forbidden. Only the men appointed to fire shots are permitted to have in their possession explosives other than blasting powder and saltpetre. No other explosives or igniters than those supplied by the mine manager, except firing tubes, may be charged into a shot-hole; and explosives so given out may not be taken away. If other explosives than blasting powder or saltpetre be used in a mine, a special journal must record the consignments received, the names of those appointed to distribute them and receive back those not used, the names of those to whom the explosives have been given out, the date of such distribution and taking back, the quantities of explosive cartridges given out or received back and the year and number of the cartridges distributed.

Storage.—Explosives delivered at a mine must be immediately transferred to a suitable magazine, which may be situated on the surface or underground.

Transport.—As regards transport to the mines, the supply of explosives must not be carried at the same time as other substances or tools; and the men in charge must warn those in the neighborhood by calling out "*Sprengstoffe kommen!*" The lighting must be effected by closed lamps not carried by those directly engaged in the transport. Explosives must not be carried in the shafts while the men are going down or coming up, and only after warning given to the men at the landings and also the engineman, who must not run his engine at a greater speed than when men are being wound, nor bring the cage down upon the stops with a shock. The men at the underground landing must carefully draw off from the cage the receptacles containing explosives, and only allow them to be taken by those authorized to receive them.

Giving out Explosives.—Explosives may only be given out underground, by the officials mentioned above, to the oldest hand of a working-place, or the man appointed to fire shots (*Schiessmeister*) when he assumes the responsibility imposed below on the oldest hand. Only those may be employed as firemen who are experienced in shot-firing, and whose names, notified to the inspector of mines, must be inscribed in the mine journal; and they must be provided with a written order signed by the underground manager and approved by the inspector of mines. Firemen and old hands receiving explosives other than powder must be personally known to the official giving them out. Iron tools must not be used for opening cases or casks containing explosives. Blasting powder and saltpetre must only be given out in the ante-chamber of the magazine; and the explosives must only be distributed in perfect condition and in the form of cartridges, while compounds with nitro-glycerine base must not be given out when frozen. No greater quantity than 13 lbs. of powder and explosive saltpetre, and half that of the other explosives, including the quantity given back by the preceding shift, may be entrusted at one time to the oldest hand of a working-place; but firemen placed over several working-places may receive as much as 22 lbs. of an explosive while for mechanical rock drilling, or in other exceptional cases, the inspector of mines may authorize the distribution of larger quantities. The explosives given out may only be taken away by the oldest hand, and in a closed receptacle which must be marked with a number and supplied by the mine manager; and blasting powder and saltpetre must only be taken away in metal boxes, and not in the same receptacle as the other explosives or igniters, which latter must not be taken away loose. The explosives and igniters not used, except powder, explosive saltpetre and firing tubes, must be brought back after each shift to the magazine, or to be a special storage place appointed for the purpose; and empty receptacles must also be brought back. The reception and storage of explosives so brought back is not regarded as constituting a fresh introduction into the magazine, so long as they remain in their receptacle; but, if three days elapse, they must be returned to the magazine and again entered in the journal. On changing a shift at the working-place, the oldest hand of one shift is authorized to remit the explosives and igniters not used to the oldest hand of the next shift; but in all other cases it is forbidden to hand explosives other than blasting powder and saltpetre to anyone else. Drawing the charges of shots which have missed fire is forbidden; and, with nitro-glycerine explosives, deeper boring is forbidden, while holes drilled near shots which have missed must have such a direction that they cannot come into contact with the latter.

Electric Motor Percussion Drill.—A percussion drill actuated by an electric motor, has long been a desideratum in every department of mining, and many forlorn hopes and practical failures may be found in the records of the patent offices of all the great engineering countries, and strange to say, the substantive basis of all these unsuccessful attempts has been a soft iron core for a piston, and two or three solenoids forming what we may call the shell of the electric cylinder.

The spirals of insulated wire that made the solenoids were the means through which direct and indirect electric currents were made to alternately attract and repel the soft iron core that was mounted on the shank of the drill. The solenoids and core however, made in every case a wasteful electric motor for communicating a reciprocating motion direct to the drill, and the result has been that compressed air has up till now been the most economical and efficient dispenser of transmitted energy for drilling in mines. No one can overestimate the value of a power drill, because drilling and blasting make the impossible possible in mining, and as the transmission of electric energy is more efficient, and more cheaply effected through cables than the energy of the compressed air that is conducted through pipes, we cannot do other than make a mistake if we under-estimate the welcome that will be given to the advent of a really successful percussive drill that is actuated by an electric motor. The failure of all these previous attempts with the solenoids and core, arose from resistance produced by induction with the consequent heating, waste of energy, destructive derangement of the motor and stoppage of work.

The prime cause of all the induction could, however, be traced to the interference of the solid core, where local or consequent polarity induced counter currents in the solenoids, and the core and the drill bar, for it was found to be impossible for the core and the drill bar to cut through the lines of force of the solenoids without setting up consequent polarity, and the resulting counter electric induction, from which a high percentage of the transmitted energy was dissipated as heat, for not only did the solenoids heat, but the core and the drill bar also, and so much was this the case that they were obliged to use two motors, that they might have one cool to relieve the other, and even then they had to use wet cloths to lay on the solenoids to keep them cool. It may be thought that something could have been done to correct these defects in the solenoid and core motor, but unfortunately the only correction possible must be found in the substitution of a new principle of action in the motor, for had the cores been built of lamina the local and consequent polarity would have been prevented, and, as a matter of course, the counter currents also, but no laminated cores could be used in these cases, because the great inert force generated at the starting and stopping, or at the beginnings and endings of the strokes, would shake the laminations loose at once, and, therefore, the structural core would have been a mechanical failure.

The first solenoid and core motors were actuated with an alternating and direct current, and to prevent sparking in the mine the direct current was commuted at the generator, but in some of the later solenoid motors a direct current only was used, and it was commuted at the drill, yet, notwithstanding these changes, no real improvement was made, and the solenoid and core motor remained as imperfect as before. We are happy to say now, however, that the electric drill has a chance of asserting its claims to that of a position of first rank as a mining tool, as a new motor, free from all the defects of the solenoid and core class, has, we learn from an article in *Kuhlow's German Trade Review*, been patented and put in practice by the firm of Siemens & Halske of Berlin, Germany. It appears that in 1891 this firm patented and put in use a rotary motor to work a percussive drill, and, of course, this means that a rotary motion had to be converted into a reciprocating one, and it does appear strange at first glance when we try to discover how a relatively slow and uniform motion could ever be made to act as a hammer that would deliver a blow of great inert force to the cutting edge of a drill, but on closer observation we discover that between the pin of the crank on the shaft of the rotary motor and the shank of the reciprocating drill springs are interposed in such a way that the energy of the recoil at the back stroke is collected potentially in the springs and is given out to fortify the momentum of the drill when advancing to strike. It is no doubt easy to see how the mass of the drill is made to accelerate during the advancing stroke, but there are other unseen matters that may escape our notice, while their effects are felt very strongly, and this is especially so in relation to the effects of heating and waste of energy, and the undue strains that affect the moving parts of the drill, arising from intermittent motion; and to remedy this defect the company have, in their latest patent, put on the crank shaft of the drill a fly-wheel that secures in the most successful manner the uniformity of motion required, while it prevents all consequent magnetic and electric induction arising from a jerky motion. To render the drill portable and easy of being removed from place to place in the mine, the drill proper is separate and distinct from the electric motor. The motor is in a chest that can be carried by men, and the rotation of the motor is communicated to the drill by a flexible shaft, so that no adjustments are required for the motor connection when fixing the drill for the performance of useful work. Altogether, this drill will be a mighty factor in the world's future of mining, for it has been a development by adaption to all the conditions of a cheap motive power, and an efficient rock drill.

The Copper Deposits of Chota-Nagpore, Bengal, India.—An excellent paper on the copper and tin deposits of Chota-Nagpore was recently read by Mr. R. Oates before the members of the Federated Institute of Mining Engineers, and the facts the paper furnishes have been made the basis of the following article: It is not difficult to see that the present time is one of transition in mechanical appliances, and in the collection and transmission of energy. When railways were first made they gave a great and unprecedented stimulus to the iron trade and iron manufacture, and this demand was succeeded by a second in the transition from wood to iron ships, and again, a third demand arose for the supply of armor plates for the protection of the sides of ships of war, and this great development was followed up by the substitution of steel for iron, and the manufacture of heavy artillery and millions of small arms for fighting men.

The present period, however, makes a great demand that is likely for a century to come to be an increasing one, and that is neither for iron nor steel, but for copper, for the manufacture of solenoids and cables for the transmission of electrical energy. The exchange, or market, for buying and selling stocks is extremely sensitive to a diminishing or increasing demand for any commodity, and, therefore, the increasing and diminishing pulse of the money market is a sure index of changes; and at the present time the rage for mining investments at London and Paris is phenomenal, and especially is this the case in the buying of shares in copper mining.

We used to reckon that when the yield of copper ore fell below 6 per cent. of metal the undertaking could not pay, but with improved appliances for dressing and smelting smaller percentages are made to pay better now than larger yields used to do. As the consumption of copper increases new deposits of the ore are sought for and developed, with the result that in every land and every clime mines are being opened, and qualified and efficient mine captains find good appointments among strange peoples and in the midst of strange scenes, such as Chota-Nagpore in the province of Bengal, and about 227 miles from Calcutta, on the eastern side of India.

The schistose formation, in which the copper ore occurs, is, as far as is known, about 80 miles in length and belongs to the sub-metamorphic period and consists of bedded schists and quartzites, and these, again, rest on a wide extent of gneiss.

As a rule the small hills that are spurs off the large ones all lie in the course of the copper belt, and what is remarkable about the matter is this, the ore is found like a stratified deposit, and is therefore remarkably persistent over a large area.

The belt has a lateral pitch of 40 degrees and everywhere gives proof of having been subject to repeated dislocations that have produced numerous joints and cracks in the ore body, and again the faces of these joints have been rubbed on each other with a grinding and polishing action caused by earth tremors, until the facets or "slickensides" have been rendered perfectly smooth, and shine and reflect images and light like mirrors.

The proof of these tremors is found in the numerous intrusions of trap rock that cut through the gneiss and the overlying schists. The most singular thing about the region, however, is its history. A thousand or more years before it appears, the more easily fused ores were mined for the manufacture of knives, hatchets and pans and other utensils for the purposes of peace and private use, and also for the manufacture of swords, daggers, arrow heads and other implements of warfare, for not only are the old excavations there to attest the fact, but the slag heaps the ancients have left doubly assert the conclusion.

The ancient miners removed the softer portion of the ore body and left the richer material as pillars to support the roof.

Coming to the practical portion of the subject that refers to the class of men that can be obtained on the spot as miners, for unless we know this, all mining experiments are but wild adventures, Mr. Oates says: "The laborers consist of *Santals*, that is aborigines, and Bengalis. They are quick to learn, and would become a very useful class of miners if they would only attend regularly at work. Native festivals, which are of almost weekly occurence, are the curse of the country. On these occasions the workmen leave without the slightest notice, regardless of the well-being of their employers. From this cause progress is slow, and the patience of the management often completely exhausted. It will be a fortunate day when the government steps in and affords the mine owners protection from such conduct."

The following, in the words of Mr. Oates, will supply a good gauge of the cost of labor: "The indurated character of the formation was a bar to speedy work, so that four men per shift of eight hours would only advance the face about 3 inches. The rate per week did not exceed 4 feet, and generally did not reach that. A pair of Cornish miners would probably drive 12 feet, or three times as much, but, on the other hand, a European would get twelve times the pay."

Fuel, timber and building materials are cheap and abundant. The ore yields from 10 to 15 per cent. of metallic copper.

The Narunga Tin Deposits.—These deposits are found in the gneiss underlying the schistose rocks of the copper belt of Chota-Nagpore in the province of Bengal as previously noticed and we base the conclusions at which we have arrived for the subject matter of this article on the observations of Mr. Oates as given in his paper on the Chota-Nagpore mining resources.

The gneiss is cut through by frequent veins of quartz, and eruptive and intrusive dykes and sills. The discovery of the tin stone was purely accidental and came about in the following manner. The natives are iron smelters in their primitive way, and one day they charged the furnace with what they thought was an iron ore, and on tapping it, much to their atonishment a white metal flowed out which they mistook for silver and they carried it off in hot haste to Raneegunge, the nearest town, when the true character of the metal was made known to the smelters. The tin bearing rocks are of considerable extent and have a general dip of 26° to the east, the strike running north and south, and as far as is now known, although the prospecting has only partially been done, tin crystals have been found scattered over a surface area of 21 square miles. What a field for mining adventure!!

Hear what Mr. Oates has to say: "Mining over an infinitesimal portion of this tin bearing area has thus proved the existence of tin beds extending to the deep, in most congenial ground, and under the most favorable conditions met with in mining in a virgin country. Not only in the Palgunj estate is in expected to be found, but also further north in Burkutta and Leda, where outcrops of tin-beds are known to exist. It is most probable, also, that further search in an easterly direction from Narungo may disclose a tin bearing formation along the south bank of the Barakur river, and across that river into the estate of Deopore, a total area, roughly speaking, of upwards of 200 square miles." Labor is plentiful and cheap. Timber is cheap, abundant, and well suited for mining appliances. The coal mines are situated at a distance of only 18 miles from the edge of the tin bearing rocks.

The stream tin deposits as may be expected in such a region are very rich, for one ton of ore was found to yield 215.2 pounds of tin, and samples of the vein were found by Mr. Samuel Gifford, of Bristol to yield the following results:

No. of Sample.	Vein Stuff.	Residue of Wash'ng.	Visible Gangue.	Tin Oxide.
	Lbs.	Lbs.	Lbs.	Lbs.
1	42	11.0	4.0	7.0
2	39	11.0	5.0	6.0
3	36	8.0	4.0	4.0
4	18	1.0	0.5	0.5
5	20	4.0	1.5	2.5
6	19	4.5	1.5	3.0
Totals...	174	39.5	16.5	21.0

Surely such a region can be made to amply repay the miner for a few years seclusion among the dark skins of Hindustan.

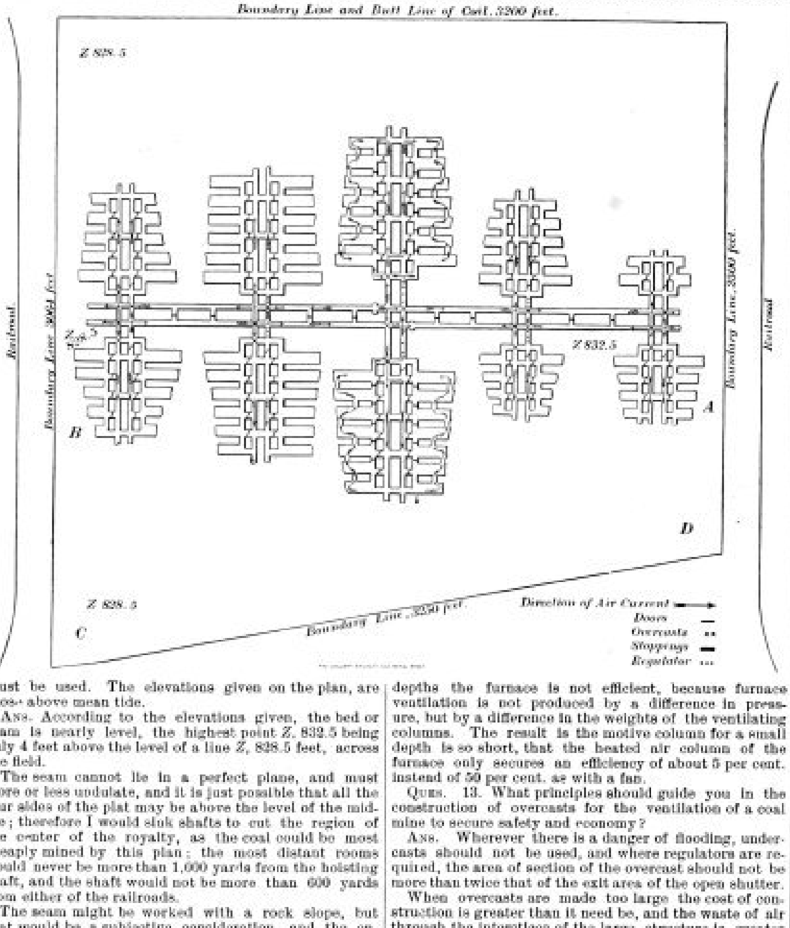
EXAMINATION QUESTIONS.

THE MINE FOREMEN'S EXAMINATION IN THE BITUMINOUS FIELDS OF PENNA. JAN. 22, 1895.

Correct Answers to the Questions, Prepared Especially for the Use of Mining Students. Practical Mining Points Explained.

9. Sketch and locate on the plan given to you, the positions of the openings, entries, airways, doors, overcasts, stoppings, and regulators; and show by arrows the directions of the air-currents:

Two accessible railroads are shown, but only one must be used. The elevations given on the plan, are those above mean tide.



ANS. According to the elevations given, the bed or seam is nearly level, the highest point Z. 832.5 being only 4 feet above the level of a line Z, 828.5 feet, across the field.

The seam cannot lie in a perfect plane, and must more or less undulate, and it is just possible that all the four sides of the plat may be above the level of the middle; therefore I would sink shafts to cut the region of the center of the royalty, as the coal could be most cheaply mined by this plan; the most distant rooms would never be more than 1,000 yards from the hoisting shaft, and the shaft would not be more than 600 yards from either of the railroads.

The seam might be worked with a rock slope, but that would be a subjective consideration, and the entrance to the slope might be at *C* or *D*, according to the railroad preferred, but it would certainly be bad mine engineering to cut the *level* bed by any other means than a shaft, unless a surface depression caused the seam to nearly outcrop, then a slope might enter the seam at such a point as would furnish the best approach to the railroad. The ventilation of the plan is arranged for the working of the coal by the system of double entry. It will be seen that the four double entry panels in the middle of the plat, are ventilated in detail, and to prevent the blurring effect of an overdone detail, the other panels are only ventilated to the doors of the bottom cross-cuts of the rooms.

10. The depth of a hoisting shaft is 200 feet; the diameter of the drum is 5 feet, how many revolutions then would a first motion engine make for each hoist, when the rope makes no overlaps on the drum?

ANS. 200 feet are equal to 2,400 inches, and as the mean diameter of the velocity ratio is 5 feet or 60 inches, plus the diameter of the hoisting rope; then let the diameter of the rope be 1 inch, when the diameter for the true velocity ratio will be 61 inches, and the number of revolutions will then be

$$\frac{2{,}400}{61 \times 3.1416} = 12.5236 \text{ revolutions.}$$

11. An airway is 10 feet wide across the floor, and 8 feet wide across the roof, and it is 6 feet high, and if the quantity passing is 60,000 cubic feet per minute, what is the velocity of the air-current in feet per second?

ANS. The transverse section of the airway is a trapezoid and its area is as follows:

$$6\left(\frac{10+8}{2}\right) = 54 \text{ square feet.}$$

The velocity per second of the air-current will then be

$$\frac{60{,}000}{60 \times 54} = 18.518 \text{ feet per second.}$$

QUES. 12. What are the principles of the ventilating fan, and is it more effective than a furnace in overcoming the friction of air in mines? If so give your reasons in full.

ANS. The principle of action in all mechanical ventilators is the same, that is they give motion to the ventilating current by a difference of pressure in the ingoing and returning ends of it, or it may be expressed as a difference in the pressures at the ports of entry and discharge or a difference of pressure in the ventilating columns. With the exhausting fan the pressure of the air is reduced at the return end, and with the blowing fan, the pressure is increased at the ingoing end.

For all mines with depths not greater than 1,500 feet, the fan is decidedly the most efficient, and even at greater depths the efficiency of the furnace does not exceed that of the fan, excepting when the furnace shaft is free from water feeders and is very dry. For mines of moderate depth the fan is very much more efficient than the furnace, because its power to exhaust the air is independent of the depth of the mine. At moderate depths the furnace is not efficient, because furnace ventilation is not produced by a difference in pressure, but by a difference in the weights of the ventilating columns. The result is the motive column for a small depth is so short, that the heated air column of the furnace only secures an efficiency of about 5 per cent. instead of 50 per cent. as with a fan.

QUES. 13. What principles should guide you in the construction of overcasts for the ventilation of a coal mine to secure safety and economy?

ANS. Wherever there is a danger of flooding, undercasts should not be used, and where regulators are required, the area of section of the overcast should not be more than twice that of the exit area of the open shutter.

When overcasts are made too large the cost of construction is greater than it need be, and the waste of air through the interstices of the large structure is greater than the waste due to a smaller one. Wherever the overcast can be cut through solid rock, certain important advantages are secured; first, freedom from leakage and waste; second, this class of overcast is not damaged and rendered inoperative by a mine explosion; third, Section 3, Article IV of The Act Relating to The Bituminous Coal Mines of Pennsylvania provides that, "In mines generating fire-damp in sufficient quantities to be detected by ordinary safety lamps, all main air bridges or overcasts made after the passage of this act shall be built of masonry or other incombustible material of ample strength, or be driven through the solid strata."

[TO BE CONTINUED.]

Electric Machinery.

The Link-Belt Machinery Co., Chicago, are still running their works day and night using the largest force ever employed by them.

Recent contracts for electrical coal mining machinery have been closed with the following companies.

Norfolk Coal & Coke Co., Norfolk, Va., consisting of two 66″ x 18 ft. boilers, one 14 x 16 McEwen engine, one 7 ft. chain breast machine, one enclosed electric grinder, circuits, etc.

Reed City Coal & Mining Co., Reed City, Ill., one 15 x 16 McEwen engine, one emery grinder, one 100 K. W. dynamo, switch board, circuits, and four 6 ft. chain breast machines.

Osage Coal & Mining Co., Krebs, Ind. Ty., one 6 ft. chain breast machine.

A Great Concentrating Plant.

The largest concentrating plant in the world is at the De Beers Diamond Mines, South Africa. The principal machinery for the immense plant was furnished by Messrs. Frazer and Chalmers of Chicago, Ill. A description of this plant will be of interest to every man engaged in any class of mining in which the production of concentrates is desirable. Messrs. Frazer & Chalmers have recently issued a fine illustrated pamphlet descriptive of the De Beers concentrating plant, which will be sent free on application. We advise all our readers interested in the subject to send for a copy.

LEGAL DECISIONS ON MINING QUESTIONS.

Reported for THE COLLIERY ENGINEER AND METAL MINER.

Breach of Contract for Purchase of Ore.—A party agreed to purchase dry ore of usual quality at a certain price per ton, guaranteed to contain a yield of 50% of iron "with a sliding scale at the rate of three pence per unit additional for every unit over 50%, and with a deduction of four pence for every unit under 50%. The ore was to be mined at C. in Spain and delivered in this country. The buyer refused to perform the contract because the ore only analyzed 48% or 49%. The seller offered to prove the custom at C. was to fix a standard of 50%, with a sliding scale, and that the purchaser was obliged to receive the mineral, provided it did not go below 45% or 46%. The Supreme Court of Pennsylvania held that evidence of such custom was admissible, and that the measure of damages is the difference between the contract price and the market price at the place of delivery when the seller discovered definitely that the buyer would not complete the contract by acceptance of the ore.

Guillon v. Earnshaw, 32 Atlantic Reporter, 545

Mining Lease.—A license for the possession of a mining claim, which by the terms of the instrument creating it is made exclusive and irrevocable, and which by reason of the expenditures of the licensees in development of the mines under the agreement, has become a license coupled with an interest, under which possession may be maintained against the world, is a lease within the law, securing a lien for work and materials furnished for the working of a mine, which shall attach to the mine.

A lease grants an estate in the land, while a license passes no estate; and when the license is mine upon the land of another, the right of property in the minerals, when they are severed from the soil, vest in the licensee. There is a clear distinction between the two, and they are further distinguished, in that the one is a corporeal and the other an incorporeal hereditament. Licenses, however, are frequently granted with terms and conditions and upon considerations which ally them closely to leases, so that it is frequently difficult to determine when the border line has been transcended, and whether or not they are in reality leases instead of licenses. A mere license while it remains executory is revocable at the pleasure of the licensor, is indivisible and nonassignable. But a license may confer either a sole or exclusive right, or simply a right in common. If it simply confers a right to take ore or work a mine it is not exclusive, and the licensor may himself take ore from the same land or mine, or license others to do so. So a license to dig and carry away all the ore in certain land does not confers an exclusive right. Such a grant shows the extent of the license, but not its exclusiveness. It is a license without stint as to quantity. Another test is, whether the grantee has acquired any interest in the land in respect to which he may maintain ejectment. But a license may amount to a lease if conferred in such manner as to give it validity; such is the case where an interest in the land is given, or where the license is for a definite period.

Stinson v. Hardy (Supreme Court Oregon) 41 Pacific Reporter, 117.

Innocent Purchaser Protected.—A judgment in an action between the heirs of a party, and persons claiming under another, as to the title to certain coal, does not affect the title to the coal of a prior purchaser from the deceased party.

Moreland v. Frick Coke Co. (Supreme Ct. Penn.) 32 Atlantic Rep. 634.

What is Essential to Conveyance of Fee to Coal.—The tests which determine a particular instrument to be a conveyance in fee of the coal as a parcel of land: (*a*) It must relate to all the coal. (*b*) The right to mine and take the coal must be exclusive of the grantor. (*c*) The grantee must agree either to mine all the coal or pay for it if mined. If the instrument contains these characteristics, it is, in legal effect a grant in fee of the coal as land. For the purposes of these rules, the word "lease" is deemed an apt word of conveyance.

Genet v. Del. & H. Canal Co. 35 N. Y. S. Rep. 147.

Catalogues, Etc.

The Jeffrey M'f'g. Co., of Columbus, Ohio, has just issued a new and handsome catalogue of elevating, conveying and power transmission machinery, which is a model of convenience and completeness. It is sent free on application.

All mine owners and mine managers will be interested in the catalogue of hoisting and haulage machinery just issued by the Robinson Machine Co. of Monongahela, Pa. It is a very neat and convenient exposition of their efficient and economizing products.

A unique publication has just been issued by the Jos. Dixon Crucible Co. of Jersey City, N. J., entitled "The Boys have Something to Say about Dixon's Pure Flake Graphite." The little publication contains the expressions of opinion of numerous locomotive engineers as to the efficiency of pure flake Ticonderoga graphite as a lubricant. "The Boys" are the men who use it and there are no better judges of the quality of a lubricant.

Pumps.

We have received from the Henry R. Worthington Hydraulic Works a copy of their General Catalogue, special edition for distribution at the Atlanta Exposition, where Worthington steam pumps are used to furnish the water supply for the grounds and for the electric fountains. The Worthington exhibit, as usual, is a very complete and practical one. The catalogue is neatly bound in a flexible board cover and is remarkably convenient in shape and arrangement. It is a publication that should be in the hands of every pump user, and should be referred to whenever the question of purchasing a steam pump, for any purpose, arises. The merits of the Worthington type of pumps are known all over the world, and the construction of "Worthington" pumps by the Worthington Works, is fully of as high a grade as the efficiency of the type.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

The Paths of Current Motion.—Diffusion of Air-Currents.—The Form of Fan Blades.—Re-entering Air.—The Drag and Trail of Currents.—Improvement in Fan Construction.—Back Pressure Due to Involute Cases.—Throbbing Produced by Ventilating Machines.—Ventilating Pumps.—Recapitulation.

88. The Paths of Current Motion.—We are simply stating a law of nature as satisfying as an axiom, when we say, that fluids when uncontrolled always move along the paths of the least resistance, but in an attempt to particularize these paths we are obliged to proceed with trepidation because they are directly opposite in character. For example, it would be correct to say that sometimes, the path of the least resistance is where the velocity is lowest, and the area of the section of the channel is greatest, as when air currents are split or diffused from one into two or more airways in mines. Again it would be equally correct to say, that sometimes the path of the least resistance of a current is where the velocity is *highest* and the area of a section of the channel is *least*, as when a stream is deflected by a curve, and the water striving to run in a straight line gathers on the outside of the curve, and as the curvilinear deflection continues the water moves at an increased velocity, and correspondingly decreased area of section. Now this must be the path of the least resistance because the water is nearly motionless along the inside of the curve, while it cuts into the outside of the bend and carries away with it tons of earth in a few hours, and if the bank consists of hard rock, then the stream is viciously active with energy due to centrifugal force, and pelts the rock with pebbles, and thus batters it away.

89. Diffusion of Air Currents.—Observe there is not in the bed of a stream any tendency to diffusion but there is a marked constriction, and this brings us to the point that requires our strictest attention, namely, that the air entering a fan does not diffuse within the blades, because it cannot do so, but runs up the advancing faces of the blades as a stream, being subject to centrifugal force, and therefore to explain this matter Fig. 125 is introduced, and to realize that the air can only move in a constricted stream, let us set a particle in motion through a fan and closely watch it. Suppose then it begins its journey at the bottom of the blade A_1, and that we are following the a_1 until it becomes a_2 when the blade A_1 has taken the position of A_2, and at last, watch a_1 become a_3, when the blade A_1 has taken the position of A_3, and we will find that the particle has been accelerating every moment during its jounrey outward, and we ask what force is there present in the movements of a fan that could still further accelerate the particle until its velocity both linear and angular was greater than that of a particle at the periphery of the fan. Let us see what would occur if diffusion took place between the blades of the fan, that is if all the air within the blades moved outward in mass then a portion of the air entering would have to move at a higher velocity both linear and angular than that of the fan blades. For example, while the blade B_1 moved through an angle of 45° to take the position B_2, the particle b_1 would have to move through an an angle of 67° 30′ to take up the position b_2 and while the blade B_1 moved through an angle of 90° to take up the position B_3 the particle b_1 would have to move through an angle an angle of 135° to take the position of b_3. It is clear then that the line of least resistance through a fan is subject to the direction of centrifugal force and as the particle is ever subject to deflection, the stream of air must run along the advancing faces of the fan blades.

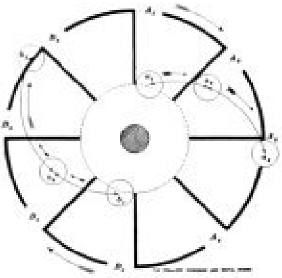


Fig. 125.

90. The Form of Fan Blades.—We cannot leave this phase of the lesson without noticing another matter correlated to the principles just treated on, and that is illustrated by Fig. 126. It was supposed that by giving the fan blades a backward or receding curvature, the air leaving the tips of the blades would by some mysterious means loss a portion of its angular velocity, and recede to be wiped gently out by the curved tips of the blades, but we see by the figure that this cannot happen, for the particle a has a tangential velocity that will carry it outward and forward, say from a to b outward, and it can never, therefore, be touched by a point in the blade, as c; or take the particle l and we can see that it will retain its tangential velocity, and can not, therefore, be touched by the particle n. Fig. 127 furnishes a still clearer light on subject, and here the particle a is seen to advance outward as a, b, c, d, and e, and the last letter is seen to be e just leaving the shoulder of the blade. At r the particle is shown as having arrived tangentially at the periphery of the blade circle, without having retreated, according to the assumption of the use of the receding curvature of the tips of the blades. At g the particle appears to have acquired a velocity, greater than either the linear or angular velocities of the shoulders of the blades, but this is impossible, and therefore sustains the conclusion we have previously arrived at, that the stream of air through a fan runs up the advancing faces of the blades, because every particle in the stream is subject to an accelerating velocity, and under precisely the same conditions of inertia as a current of water running round the bend in a river, and as we might foreknow, the air within a fan behaves in other respects like the water of a stream, subject to the action of centrifugal force. Perhaps no better mode can be given of explaining the drag and the trail of fast running water by the side of still water, or of fast moving air beside relatively still air, than by proceeding with the aid of Fig 128.

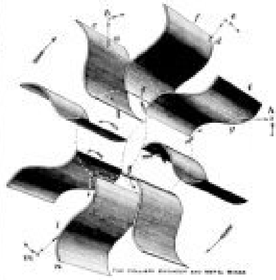


Fig. 126.

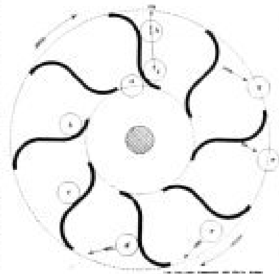


Fig. 127.

91. Re-entering Air.—The streams of air running up the advancing faces of the fan blades are shown by different diagrams of efficiency on each blade, and the object of this arrangement is to show the volumes of air due to the different angular velocities of the fan; for example, at f the fan is supposed to be running slowly, and at the blade e, the velocity has been increased, and consequently the depth of the stream is shown to be greater, but let us be careful to notice that this supposed increase in the depth of the stream is given, not as a diagram of volume, but of velocity; because, if the velocity of the stream is doubled, the volume of discharge will be doubled without any increase in the depth of the flow. At d, c and b the velocities are quick, very quick and quicker, and at a the velocity is seen to be quickest, and it really appears that we might have stated all this without hazard and without a diagram, but let us proceed to notice that the different velocities of the air streams in a fan generate a serious interference by causing a re-entry of air and thereby entailing a considerable loss of useful effect.

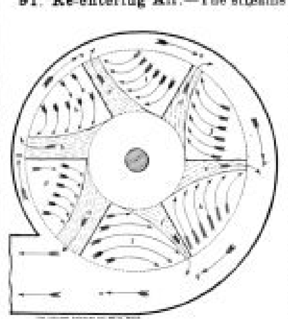


Fig. 128.

92. The Drag and Trail of Currents.—It is impossible for a rapid stream of water round a curve to have its inside limit so sharply defined that the moving particles of water can glide past the particles at rest along its inside boundary plane without moving them; and indeed they are moved, and sometimes large eddies or whirls are set in motion, beside innumerable small ones, and what takes place in the water stream takes place under the excitement of the same cause in a ventilating fan of open construction.

There is, however, in a fan with a clear open discharge either into an evolute case or into the open air, a cause of interference with the incumbent air between the blades, and that is the depression in the rear of the blades, whereby the outside discharged air is made to re-enter, and the re-entered air is next ejected by the drag and trail of the air streams, as their surfaces swiftly wipe up and carry with them the particles of re-entered air. The principal directions in which the re-entry streamlets flow into a fan are shown in the figure, and also the modifications of these movements due to the different velocities of the fan, as at g, h, i, j, k and l.

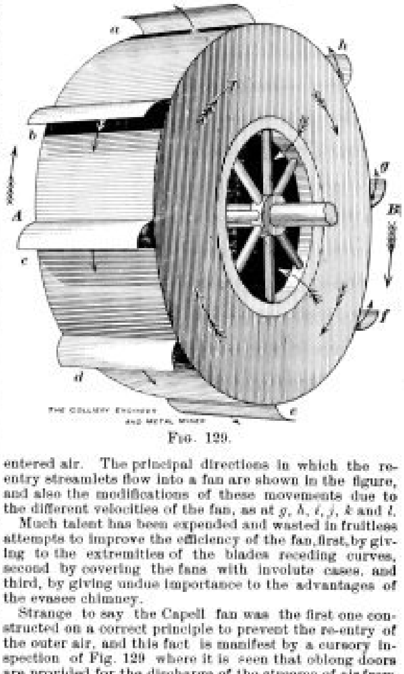


Fig. 129.

Much talent has been expended and wasted in fruitless attempts to improve the efficiency of the fan, first, by giving to the extremities of the blades receding curves, second by covering the fans with involute cases, and third, by giving undue importance to the advantages of the evasee chimney.

Strange to say the Capell fan was the first one constructed on a correct principle to prevent the re-entry of the outer air, and this fact is manifest by a cursory inspection of Fig. 129 where it is seen that oblong doors are provided for the discharge of the streams of air from the blades, while the rest of the cylindrical space is covered with a close shell to prevent the re-entry of air, and experience has proved most conclusively that this was a step in the right direction, as we shall just now show most clearly. Every opening or port of discharge was in the first Capell fans covered with a reaction cap with the intention of recovering the otherwise lost energy of discharge by first deflecting the outflowing air in such a way, that its tangential velocity would be neutralized and second, it was expected that the inertia due to the

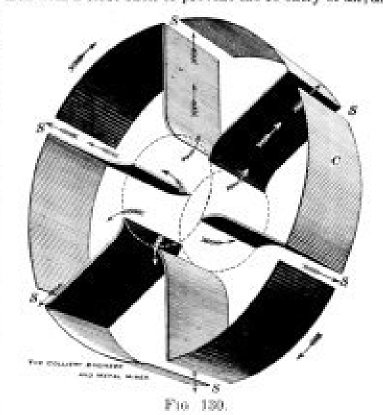


Fig. 130.

arresting of the motion, would react on the caps, and thereby restore the otherwise "great" loss of energy; but the resistance due to the excessive friction of the air pressing unduly on the under surfaces of the caps and the wasted energy lost by the caps beating against the external air, was found to be greater than the gain. The caps are seen *a*, *b*, *c*, *d*, etc., the direction of the motion of the fan is shown by the arrows *A* and *B*, and the supposed directions of the ejected currents are shown also by arrows.

93. Improvement in Fan Construction.—The caps are now dispensed with in the Capell fan, and as far as the cylindrical shell and the ports of discharge are concerned it is now like Fig. 130, and the ports of discharge are seen at *S*, *S*, *S*, etc., and the closed shell is marked *C*.

The closed shell and ports did not however altogether prevent the rotary motion of the air between the rears of the blades and the surfaces of the outflowing air streams, for it now only changed in character and became truly cyclonic as shown at *d* and *e* Fig 131. We might conclude that these innocent eddies could not seriously interfere by setting up a high resistance within the fan, but this is a mistake because the air of these whirls turning at a very high velocity would meet with considerable resistance, first from friction, but second, and most of all from the arresting of the motion of the air when thrown off tangentially from the whirl, for then it is constantly in course of being arrested and of being set in motion, and the energy thus wasted directly reduces the efficiency of the fan. To prevent this waste, Capell has come to the rescue again as shown by Fig. 132.

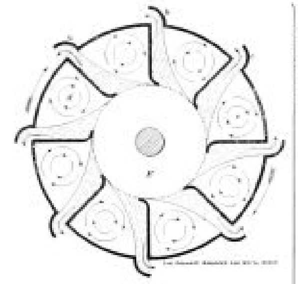


Fig. 131.

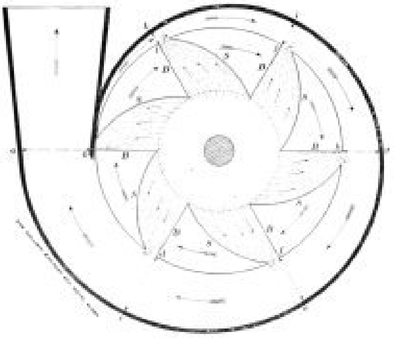


Fig. 132.

This cut was actually made by the direction of the writer, before he had seen a drawing of Capell's latest patent, and by the figure it will be seen that the writer introduces covering constricter blades that confine the air streams within a proper depth on the advancing faces of the propeller blades. The covering blades are marked *S*, *S*, *S*, etc., and the propeller blades are lettered *B*, *B*, *B*, etc., and the spaces between *B* and *S* are chambers that contain confined air, cut off or isolated from the air streams on the propeller blades. Capell claims that he has by this means increased his efficiency, others that have tried his fans support his conclusions, and the evidence that has been produced from deductions out of the operations of mechanical law, appears at any rate, to be irrefutable.

94. Back Pressure Due To Involute Cases.—The back pressure due to the resistance or friction in the path of the swiftly moving air, discharged through the involute case of a fan, is at any rate as great as the gain of reduced resistance, in the evasee chimney. In short, the involute case and the evasee chimney do not, except in the case of the blowing fan, increase the efficiency when the joint areas of the ports of discharge are sufficiently reduced to prevent current oscillation. The Waddle fan is without an involute case, and, therefore, without an evasee chimney, and we cannot conceive how the addition of these costly appurtenances would improve the efficiency of that fan. It is true that where there is no enclosure over the spaces between the propeller blades, an involute case and an evasee chimney are essential, but where the blade ports of discharge are reduced to a correct area, and especially by constricter covering blades, the involute case and the evasee chimney cannot increase, but rather reduce the efficiency of a fan. Back pressure is necessary at the discharge of a fan, but at most it is only a small fraction of the mine resistance, and yet the proportionate value of this fraction varies with fans of the same make, exhausting from different mines that are like as many organ pipes, of different wave pitch. It would appear at first glance that the involute case supplied the required back pressure without any further reduction of the ports of discharge from the propeller blades, but we have learnt that by so doing we introduce other causes of waste, such as the re-entry of air between the blades, and, therefore, we see that to improve a fan, due attention must be given to the ports of entry, to see that they are large enough to prevent needless waste of energy, and for the same reason we must so adjust the areas of the ports of discharge, that the back pressure is just sufficient to prevent the re-entry of air, or we must provide covering constriction blades, to prevent the formation of revolving cycles, that consume energy by the constantly arrested tangential motion of these air streams.

95. Throbbing Produced By Ventilating Machines.—The wave motion that is so detrimental to the efficiency of mechanical ventilators, is strongly pronounced, where the engine is on the same shaft as the fan, or on the first motion, and the steam is used at a high pressure with an early cut off.

Here the throbbing due to the intermittent action of the fan can be felt as a strong pulse in the furthest nook of the mine and so strong is your perception, that you can count the strokes of the engine. Careless observation in these matters, has made many costly experiences where rotary and reciprocating pumps have been tried to secure a greater efficiency than that of the fan. The inventors of the ventilating pumps did not foresee the loss of energy that would occur by setting air in motion with a varying velocity, and consequently these machines have all rapidly fallen out of use, and we only introduce them here to interpret the mechanical laws that operate in all other machines used for ventilating mines.

96. Ventilating Pumps.—First then let us notice Nixon's ventilating pumps as illustrated by Fig. 133.

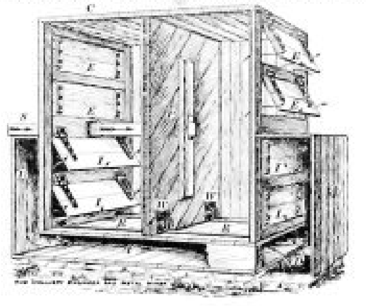


Fig. 133.

They made the air move in distinct gusts and it was expected that they would directly force the air, without any recoil whatever, and would replace the machines that depended for their action on the operation of the "mystical" centrifugal force. None of these expectations, however, were realized, because the loss of energy due to intermittent action, and the resistance at the door valves was so great, that these machines were very far behind the worst examples of the centrifugal fan in efficiency. The figure furnishes an example of a reciprocating piston pump, that is oblong in its transverse section, the piston being 20 feet high and 12 feet wide as shown at *P*. This heavy moving partition was made to run with very little friction on wheels rolling on rails fixed on the floor of the pump chamber, as *W*, *W*, and *R*, *R*; the wooden piston rod or spear *S*, was connected directly with the piston rod of a steam cylinder of very long stroke and the piston *P* is now according to the indication of the arrow and the positions of the valves, moving from left to right. It will be seen that two valves at the "top left" and other two at the "top right" and marked *E E* and *E E* are delivery or ejection valves and open outward, and that two at the "bottom left," and other two at the "bottom right" open inward, and are intake or injection valves, as *I I* and *I I*. The injection valves are connected with an air drift, as *T* and *F*, and these flues are in open connection with the shaft or slope at *D*. When the piston is moving from the left, the "left bottom" injection, and "right top" ejection valves are open, and consequently when the piston is moving from the right, the "right bottom" injection and the "left top" ejection valves are open. Fig. 134 illustrates in vertical section, Cook's rotary ventilating pump. The wind wave pulse due to this pump was painfully manifest, and it was difficult indeed to obtain a correct reading of the mine resistance in consequence of the unsteadiness of the water levels in the gauge as they oscillated rapidly.

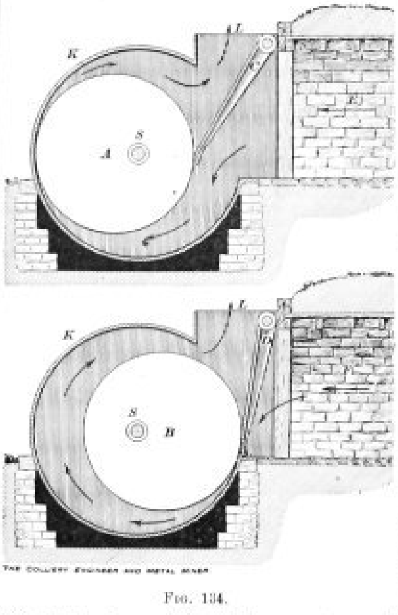


Fig. 134.

Several of these rotary pumps were set to work at the iron mines in Cleveland, Yorkshire, and at the coal mines in Durham, England, and the writer recently noticed in the *Colliery Guardian*, that the last of these machines in Durham was lately replaced with a fan at Hutton Henry Colliery, Wingate, Durham. This pump first consisted of two cylindrical drums *A* and *B*, set in separate cases *K*, *K*, side by side and mounted on the same shaft *S*. The drums were from 10 to 16 feet in diameter and from 8 to 10 feet in length. The main shaft passed through the centers of the cases, and the drums were mounted eccentric to the shaft, so that when the oscillating shutter *D*, closed the mouth of the drift the center of the drum *B*, was right of *S*, and when the mouth of the drift was wide open at the shutter *C*, the center of the other drum was left of *S*. Now as a drum revolved one side was always nearly touching the inside surface of the circular case, while the shutter was oscillated by a crank on the hinge ends of *C* and *D*. The shutters were the same in breadth as the drums were in length, consequently it is easy to see that, as the eccentric drums revolved and the shutters so oscillated that they always nearly touched them with their tips, the pair of drums constituted a double acting pump having their intake at the drifts *E* and *F*, and their discharge into the open air at *L*, *L*. In looking into this pump, from the standpoint of *L*, when it was in motion, you felt as though you were at sea and as the huge gas tank-like drum came swelling up it seemed very like the roll of a huge wave. There were three serious shortcomings in this machine.

First, the re-entry of air was very great, as the drums could not closely touch the case either on the face or at their ends, and the tips of the shutters were always about an inch and a half from touching the drums.

Second, the machine could not be run at a speed of more than 20 revolutions per minute, because the centrifugal force, due to the rotation of the eccentric drums, would otherwise break the shaft or tear it out of its bearings.

Third, the drums made such a variable depression in the drifts that the loss due to intermittent action made it an exceedingly wasteful motor for mine ventilation.

97. Recapitulation.—1st. There are two paths of the least resistance in current motion, and true to one of these paths the stream of air through a fan is confined or constricted on the blades.

2nd. We have noticed the reasons why diffusion does not occur between the blades of a fan.

3rd. The retreating curvature of the outward extremities of the fan blades is wrong in principle and wasteful of energy.

4th. The waste resulting from the eddy movements produced by the re-entry of air between the blades ought to be prevented.

5th. There should be a separate port of discharge for every blade in a fan, and therefore the open space between the blades should be partially covered to prevent re-entry.

6th. The waste within the fan blades, even when covered, as the result of cycloidal eddies casting off the rotating air tangentially, when the energy of the moving particles is wasted by their motion being arrested.

7th. The importance of the Capell constricter covering blades.

8th. The loss due to the intermittent action of reciprocating and rotary air pumps.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

Oils Used for Illumination.—The Behavior of Burning Oils.—Smoking and Non-Smoking Oils.—The Three Stages of Combustion.—The Causes of Smoking.—How to Test Oils for Safety Lamps.—Photometric Measurements.—The Two Modes of Measuring Light.—Shadow Measurement.—Measuring Light by Equalization.

69. Oils Used for Illumination.—It is now our business to become acquainted with the various illuminants that are in use in mines, and as many of them are only different in kind and not in character, the investigation of the whole matter will not therefore require the expenditure of much of our time.

In so far, however, as the physical properties of these luminants are concerned, they are recognizable under four heads, as, electricity, coal-gas, the fixed oils and the volatile oils, and it will be chiefly with the fixed and the volatile oils that we shall be engaged, as they are the chief illuminants in use in mines.

The fixed oils are vegetable and animal productions that can be separated from their containing tissue without the application of heat, and are such as olive-oil, palm-oil and cocoanut-oil, etc. Nearly all the oils obtained by great heat and distillation are volatile, that is, they evaporate at ordinary temperatures as gas, and such are often called "spirits," as "methylated spirit," spirit of turpentine, spirit of sugar or alcohol, etc. Many of the mineral oils are very volatile when heated above 90° F., as petroleum, benzine, etc.

70. The Behavior of Burning Oils.—The burning of these oils is full of interest to the miner, and not only from the standpoint of their use as illuminants, but from what we learn in the burning of these different oils.

All the oils are hydro-carbons, and, strange to say, the individuality of the oils in every case, results from the greater or lesser proportion of carbon contained in each compound; and more remarkable still, the fixed oils contain more carbon than the volatile ones, and beginning with CH_4 or marsh gas, and continuing through a series of gaseous hydro-carbons, we at last reach a compound of carbon and hydrogen, in which, if the temperature of the gas is reduced, it becomes a spirit, and after this, with a little more increase of the carbon element, we get a volatile oil, and with a still greater increase of carbon we get a fixed oil, and with a further increase of carbon we get a solid fat, or wax, and with a still greater increase of the carbon element we get resin, pitch or bitumen.

71. Smoking and Non-Smoking Oils.—The reader must have noticed that in burning alcohol, methylated spirit, or spirit of wine, all three being nearly the same compound, we obtain a very hot flame with very little illuminating power and no smoke. Now the illuminating power of a flame is the result of a vast number of unburnt solid particles having had their temperature raised to a white heat, and in this state they emit light; if however, these particles are burnt as in the case of the carbon in a Bunsen flame, then the flame of olefiant gas gives no more light than that of the flame of alcohol. This brings us to the sought-for point, namely, good light is the result of the imperfect combustion of a portion of the carbon in the flame under notice, and there are three stages in the combustion of the carbon that are of first-class importance, and especially so when we notice, that we are always trying to obtain the best possible light with the smallest consumption of oil.

72. The Three of Stages Combustion.—The first stage occurs when all the carbon is completely burnt as in the Bunsen flame.

The second stage occurs when much of the carbon is burnt, and just sufficient remains unburnt to give a good light, without a smoky flame.

The third state occurs when very little of the carbon is burnt, and it is therefore nearly all set free as a dense black cloud of soot and smoke, making the air thick and suffocating.

There are four causes of the production of smoke by the flames of lamps.

73. The Causes of Smoking.—The first cause is, carbon will not burn in oxygen until it reaches the temperature of incandescence; the result is, if cold air chills the flame it prevents the ignition of the carbon.

The second cause is an insufficient supply of air to carry on the combustion of the gas evaporated by the burning oil.

The third cause is the high proportion of carbon in a thick oil, burning with a thick wick.

The fourth cause is the too rapid volatilization of the oil when more gas is evaporated than the limited supply of air to the surface of the flame can burn; for example, the proportion of carbon in turpentine is very much less than in resin and yet so rapid is the volatilization of the gas from turpentine when heated, that the flame gives off more black smoke than that of burning resin. From all this we see that different oils contain different proportions of carbon, and are quicker and slower in their volatilization, hence some are better adapted for one use and some for another, and this brings us to the point where we should be able to determine the adaptability of an oil for producing light in a miner's safety lamp.

74. How To Test Oils For Safety Lamps.—After a little investigation we discover that the destructive analysis of the oil is not the best mode of testing, and an easy and correct gauge can be applied by finding the length of the funnel required to produce a clear light without smoke. First, then let us refer to Fig. 114, and it will be seen that the flame is capped with a lazy cloud of smoke, as the result of the too rapid volatilization of the oil at the wick W, or the too rapid conversion of the liquid oil into gas; and a further cause is found in the small supply of oxygen, as it can only enter into active combination with the combustible gas at the surface of the flame F, as shown by the arrows a, b, c, d. In these days of "kerosene lamps," the smoking of the flame before the funnel is fixed is a familiar experience, and the change produced by the addition of the chimney is very pronounced, and we can, therefore, imagine that there will be degrees in the completeness of the change from imperfect to perfect illumination; for example, the case before us is the worst so far as light is concerned, and if we add a very short chimney we would slightly improve it, and a longer one more so, and as this is the case, we may also see that a length of chimney that would produce a good light with one sample of oil would not be long enough to do the same with another.

Fig. 114.

It is evident then we have at our disposal one of the most simple and decisive tests of the fitness of an oil for use in a miner's lamp. Smoke is generally prevented by applying a draught to the flame, but the motive column to produce a draught in a miner's lamp is very small, and when we consider how a small increase of carbon in the composition of the oil, or a small increase in the rapidity of the volatilization of the oil, or further, when we consider the resistance the air has to overcome in forcing its passage into and out of the lamp through the meshes of the gauze, we cease to wonder at the much repeated cry of "bad oil." For to explain then, how the oil is tested for its fitness to be used in miners' lamps Fig. 115 is introduced, and as we may expect, the process is dependent on the use of standard values such as cotton wick of a fixed size, and a glass chimney 3 inches long. Tin-plate vessels for oil wells are provided, and these are filled with the oils to be tested as shown in the figure at D and E. Now to make the explanation easy to comprehend, let us make a test "in fancy," and first try the short chimney on E, and here the flame is found to smoke freely; next try the long chimney B, and now the flame is found to be clear and smokeless, but we could not provide to have a draught equal to this in a miner's lamp, therefore, however good the oil may be as a lubricant and even as a luminant in a good draught, it is nevertheless unsuited for burning in a safety lamp. Again, try the short chimney on the sample D and here it is found to burn brightly and without smoke, and now we conclude this oil is as good as any we can buy for safety lamps, and therefore the sample D is accepted.

Fig. 115.

75. Photometric Measurements.—Oils have not only to be tested for smokeless flames, but also for their illuminating power, and lamps also require to be tested to determine their efficiency of diffusion. For improperly constructed lamps set up an interference or obstruction to the free passage of light.

We therefore require a simple test for measuring the illuminating power of oils, and the efficient dispersion of the light by lamps. For these tests we also require a guage based on standard and accepted values, and the gauge for safety lamps is one candle power.

76. The Two Modes of Measuring Light.—There are two modes of measuring the illuminating powers of flames and the first is based on an adjustment for the equalization of shadows, and the second is based on an adjustment by which one light is made to equalize the light of another, when both illumine one point.

The intensity of light varies inversely as the squares of the distances of points from the luminous centres, as, for example, let some distances from the luminous points be 1, 2, 3, 4, 5, 6, 7, 8 and 9, then the intensities of the light at the distances will be 1, $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, $\frac{1}{25}$, $\frac{1}{36}$, $\frac{1}{49}$, $\frac{1}{64}$ and $\frac{1}{81}$.

This means to say that if the intensity of the light at a distance of 1 is 1, then at a distance of 9 it will be $\frac{1}{81}$. Perhaps there is not to be found a better teacher tha that furnished by an example, and for this purpose. therefore, let us introduce Fig. 116. This is the most easy method known for measuring the illuminating

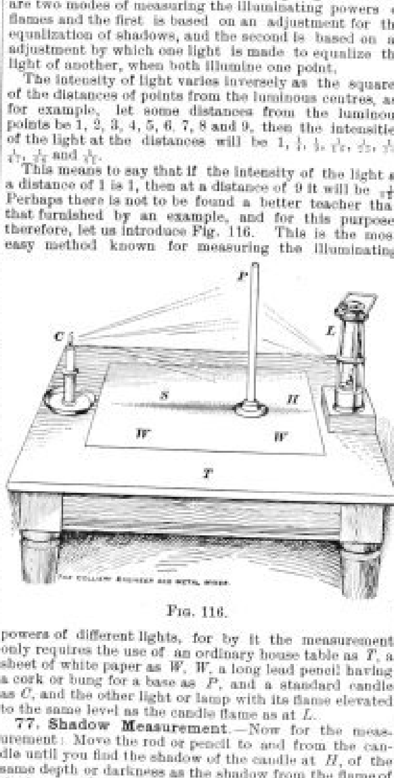


Fig. 116.

powers of different lights, for by it the measurement only requires the use of an ordinary house table as T, a sheet of white paper as W, W, a long lead pencil having a cork or bung for a base as P, and a standard candle as C, and the other light or lamp with its flame elevated to the same level as the candle flame as at L.

77. Shadow Measurement.—Now for the measurement: Move the rod or pencil to and from the candle until you find the shadow of the candle at H, of the same depth or darkness as the shadow from the flame of the lamp at S, and when the shadows are thus equal in darkness, then the lights are proportionate in illuminating power to the squares of their distances from the pencil, and suppose the lamp L is distant 10 inches from P, and the candle C, is distant 20 inches from P, then if the candle be taken as the unit of measure, the illuminating power of the lamp is $\frac{10^2}{20^2} = .25$, or the lamp is .25 candle power. Again, if the lamp be taken as the unit of measure, then the candle is $\frac{20^2}{10^2} = 4$ lamp power. Lamps are, however, always reckoned in candle power.

Fig. 117 is another illustration of a photometer or light measurer, and in this case also the means employed are of a simple character. Two boards are joined

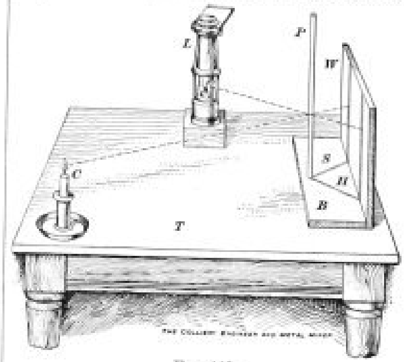


Fig. 117.

together in such a way, that one is perpendicular to the other, as B and W, and they are covered with white paper and a pencil rod is fixed in the base board as at P. By this means the candle C is made to cast a shadow as shown at S, and the lamp is made to cast a shadow on the base and the upright board as at H, and if the lamp is moved alternately nearer and further from the pencil until the shadows are equal in depth, then the powers of the lights, are as before directly proportionate to the squares of their distances from the pencil. Suppose in this case the lamp is distant 11 inches and the candle is distant 17 inches, then the candle power of the lamp is $\frac{11^2}{17^2} = .418 +$.

78. Measuring Light by Equalization.—Fig. 118 is an illustration of the photometer often met with at gas works, and in this case a disc D is moved to and fro

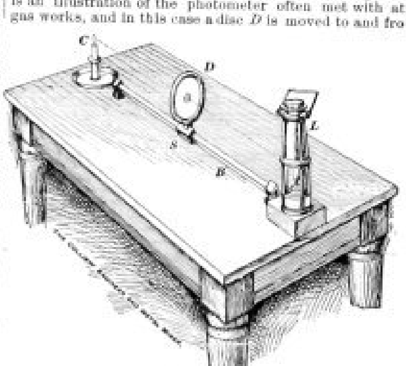


Fig. 118.

on a bar B, until a spot of oil on the centre of the paper diaphragm, fixed in the sliding sleeve at S, appears quite black. Now if S is too near to C and you look at the diaphragm from the L side, a light is seen from C, or if it is too near to L and you look at the diaphragm from the C side you can see light from the lamp, but if S is set at a point where the two lights are of equal intensity then no light is seen by looking at either side and the spot appears black, and if the distances are now measured, and are found to be L 20 inches and C 30 inches, then the candle power of the lamp is $\frac{20^2}{30^2} = .44 +$.

[TO BE CONTINUED.]

MINING METHODS.

High Pressure Ventilation—Terms Used in Ventilating—Potential, Velocity and Pressure—The Situation of Mine Shafts—Directions of Currents Along the Faces of Workings—Favorable Conditions for Ventilation—Recapitulation of Facts.

72. High Pressure Ventilation.—Erratum: In our last chapter, in the November number, the last formula, $P - \left(P\frac{Q^2}{q^2}\right) = p$, should have been $P - \left(P\frac{q^2}{Q^2}\right) = p$.

The difference of current potential, or the power that sets the ventilating air currents of a mine in motion, is greatest when the workings are situated upgrade from the shafts, or where the shafts are situated at the bottom of the pitch. The reason for the high pressure required to ventilate a mine with the ingoing air ascending and the return air descending, is soon found and as easily explained, but there are other matters of great importance involved in this investigation that claim our attention; for example, a high pressure implies great resistance and a reduced current velocity, or a great expenditure of cost to produce the energy required for the high resistance to be overcome.

It is a mistake to act on the supposition that a large volume of air is all that is required for the complete and satisfactory ventilation of a mine, because a large volume of air is often found to be circulating, while some of the upgrade districts in a mine are standing, not only charged with gas, but with a stagnant ventilation. Here, then, we are confronted with two facts that require explanation; first, much gas and an inefficient ventilation, while all the other districts in the mine have a more than sufficient quantity of air circulating; second, the upgrade workings are not ventilated, while the downgrade workings contain no gas and are ventilated with a "strong breeze of wind." What, then, is the cause of this opposite condition of the upgrade and downgrade workings? The answer is, the current pressure is too low to overbalance the descending return current, that has been rendered specifically lighter by being heated and mixed with marsh-gas. We see, then, that a high current pressure is as necessary for the complete ventilation of a mine as a large volume of air.

The first proposition is a satisfactory introduction to to the solution of the problem that a mine always requires a high current pressure when the shafts enter the seam at the bottom of the pitch of the upgrade workings.

73. Terms Used in Ventilating.—To make all this clear it is necessary in the first place to define our terms and the most important ones are those of "potential," and "difference of potential." Potential means the disposable power that sets the ventilating currents in motion and speaking of the entire mine it may mean 1,000,000 units of work. The "difference of potential" can be best explained with an example. Suppose an airway to be 6,000 feet long, and that a quantity of 60,000 cubic feet of air per minute passes through it with a pressure of 10 pounds per square foot, then the potential of the ventilation of that airway is $60,000 \times 10 = 600,000$ disposable units of work, and the difference of potential will be seen and understood if we divide the airway into two equal halves as 3,000 feet from A to B, and from B to C other 3,000 feet, or if the potential or disposable power at A is 600,000 units of work, at B it will only be 300,000 units of work disposable, or the difference of potential between A and B is $600,000 - 300,000 = 300,000$, and the difference between A and C is 600,000. The difference of potential for every foot of the airway is $\frac{600,000}{6,000} = 100$.

74. Potential, Velocity and Pressure.—Another matter requires close attention and it is this: The potential that would set up a high velocity against a low resistance, would only set up a low velocity against a high resistance, because the pressure required to remove gas downgrade is obtained at the expense of the velocity of the current. For example, suppose that by some unknown cause the airway, we have just noticed as 6,000 feet long, has been nearly closed at the end C, then in that case nearly all the ten pounds pressure per square foot setting the air in motion at A, would be found as static pressure at C. Or this means, as before, you cannot obtain pressure to remove gas without doing so at the expense of the velocity of the current; and independent of all the differences in velocity that arise from splitting, greater differences are produced by the resistances set up by return air-currents that are descending from upgrade workings and have been rendered light

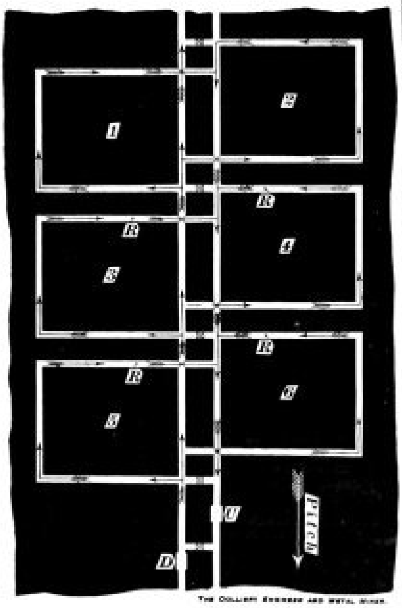


Fig. 118.

by being heated and charged with marsh gas. Where the air-current is moving at a low velocity, it is not easy to mix the air and the gas so that the latter may be removed, but under these circumstances it is wise to ventilate by ascension along the working face, and make the rapid main currents descend, as shown in Fig. 118.

75. The Situation of Mine Shafts.—Here the shafts are below the upgrade workings, the result is the ingoing fresh air has to ascend, while the return light air has to descend. The directions of the currents may be traced by the arrows, and the movements of the local currents in the panels are seen to be all ascensional, and, indeed, if this provision was not made, the resistance would be very great. A little explanation of the figure will assist in making the previous remarks still more evident. The direction of the pitch is shown by the arrow. The districts most distant from the shaft as 1 and 2, are seen to require no regulators, but they are provided for the districts 3, 4, 5, and 6. It is commonly said that the regulators in the districts near the shafts, are to prevent too much air circulating in those panels, but the real use of these regulators is to throw forward a greater difference of potential, for the ventilation of districts 1 and 2.

76. Directions of Currents Along the Faces of Workings—Fig. 119 shows the air currents moving downgrade along the working face, and the disadvantages of this mode of current motion are two in

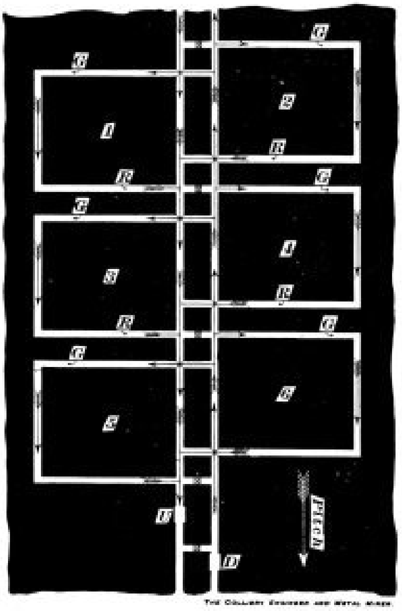


Fig. 119.

number, for it may be said, the system is bad *altogether*.

First, when the main airways and the working face are all downgrade to the shaft, a very high potential is required for the ventilation of the mine.

Second, when the regulators as shown at 1 and 2 are used, they are entirely out of place, as they introduce a resistance that is already too great, and any gas collecting behind them would stratify, and the little air that did pass along the working face would blow through the

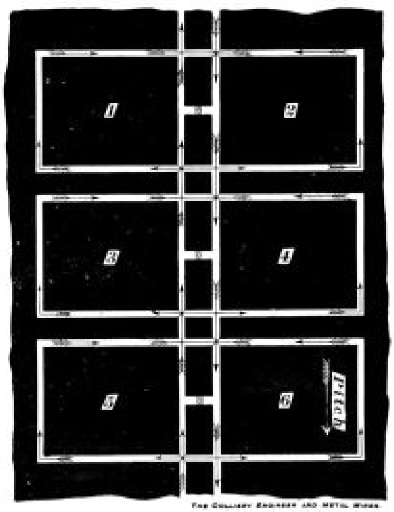


Fig. 120.

regulators and leave the gas behind. The same conditions would prevail in panels 3 and 4, only a little modified, and even in panels 5 and 6 it would require the full force of the wind blowing without regulators, to remove gas.

77. Favorable Conditions for Ventilation.—Fig. 120 illustrates the most favorable conditions for ventilating a mine with a small potential. Here the seam is entered at the top, or the beginning of the pitch with slopes, and the ingoing air descends, while the light gas-charged return air ascends, and even the currents along the working faces in the panels are moving upgrade. The regulators are not shown, but if used they should be fixed at the ends of the return airways of the panels 3, 4, 5 and 6. Strange to say regulators can often be dispensed with in a mine of this kind when worked and ventilated as shown by the figure, because the panels low down the pitch have their ventilation aided by the ascending current, that is heated and charged with light gas. Contrast this figure with the former one, and we will find the reasons for the high potential required for the preceding example, and those for the low potential of the present one. For example, suppose the potential required to ventilate the workings of a level seam was taken at 4, and the potential required to ventilate an inclined seam with the shafts at the bottom of the pitch was 6, then if the inclined seam was entered at the top of the pitch with slopes, the potential would be infernally 2, and therefore, we see that the potential required to ventilate with shafts at the bottom of the pitch, is 6, or $\frac{6}{2} = 3$ times greater than that required for ventilating the workings by slopes entering at the top of the pitch.

78. Recapitulation of Facts.—Let us now recapitulate the facts of prime importance in the lesson; First then, with a given potential, this disposable energy overcomes a great resistance by reducing the square of the velocity of the air current and correspondingly increasing the pressure. Second, to remove gas in upgrade workings, the velocity may be so reduced, as to raise the pressure almost up to its static value, or to that required for the ventilation of an entire mine. Third, the air current along the working face should move upgrade, when the line of the face pitches. Fourth, the slopes or shafts secure the least expensive ventilation, when they enter the seam at the top of the pitch. Fifth, regulators are often dispensed with when all the return air-currents of the mine have an ascending motion.

[TO BE CONTINUED.]

A Good System for Your Store.

A question that has bothered the different mining companies for a good many years is "What is the correct and best system to use in our store?" Stores which are run in connection with mines are generally in an isolated locality, and the store must have some system to prevent employes over-running their account at the store. A great many have adopted a round metal check, but it does not give the satisfaction the storekeeper or managers might desire. In the first place they are transferable and are good for merchanise at the store to whoever brings them in. Again, being transferable employes can sell, or otherwise dispose of them, and frequently a man's family is deprived of his earnings because he is too weak to resist the fascination of a poker game or a game of craps. Sometimes a rival store gets hold of a number of these checks and presents them for payment at inopportune times and causes a great deal of worry to the mine.

Another sysytem that has been tried with a greater or less degree of success is the old script or punch out ticket. These while they are not generally transferable have faults nevertheless. The employe says: "Hold on, you have punched out too much." The customer holding such ticket is usually looking for the worst of it, and after he thinks that the little punch has cut too wide a swath in his ticket, there is no way of convincing him that he has not been swindled. The punch out ticket is usually printed on a simple card which could easily be counterfeited, is easily destroyed or disfigured, and is the cause of many misunderstandings between the customer and proprietors.

The best system that has been brought to our attention is the Coupon Book. This system is calculated to take much trouble and worry off the mind of the man whose mine has a commissary annex. They are put up in book form, each book containing different amounts. These books generally represent \$1, \$2, \$3, \$5, \$10 or \$20 and have coupons in the books running from one cent or five cents up to 25 cents or a dollar as the store manager may deem best. It seems to us that the coupon scheme is vastly superior over any system of punch outs or metal checks. The book itself is not transferable and is good for merchandise only at the company store and only to the man to whom the book is issued or some member of his family. In the book the coupons are perforated so as to be easily detached, and after these are once torn out by the clerk at the store, they are worthless, as they are not good if detached. A man cannot claim that you punched out too much, or rather tore out too much, as the amount detached from the book is laying on the counter before the clerk and the customer. As they are not transferable, they cannot be sold. In fact the superiorty of the coupon book over any other system can readily be seen. The paper check wears out, is difficult to handle, bulky and unwieldy after short use. The coupon being not good if detached does not become a circulating medium and therefore offends no law, the Coupon Book being in substance simply an order to the employe on the store for a certain number of dollars worth of goods to be delivered in partial deliveries, and upon each delivery coupons to the value of such delivery are detached until the book is exhausted. We know that a large number of concerns have adopted this system within the last few years, and it seems to us that it will be used by a still greater number as soon as its merits are discovered, as the system wherever given a practical test becomes popular both with the employer and employe. Next to cash drawn by employes on account, it is the best system that can be devised for the convenience of employes, and it is therefore popular with them.

MISCELLANEOUS.

WHAT CAUSES THE LIGHT OF THE SUN.

The light of the great orb of day emanates solely from a closely fitting robe of surpassing brightness. The great bulk of the sun which lies within that brilliant mantle is comparatively obscure, and might at first seem to play but an unimportant part so far as the dispensing of light and heat is concerned. It may indeed be likened to the coal cellar, whence are drawn the supplies that produce the warmth and brightness of the domestic hearth, while the brilliant robe where the sun develops its heat corresponds to the grate in which the coal is consumed. With regard to the thickness of the robe, we might liken this brilliant exterior to the rind of an orange, where the gloomy interior regions would correspond to the edible portion of the fruit. Generally speaking, the rind of the orange is rather too coarse for the purpose of this illustration. It might be nearer the truth to affirm that the luminous part of the sun may be compared to the delicate filmy skin of the peach. There can be no doubt that if this glorious veil were unhappily stripped from the sun, the great luminary would forthwith lose its powers of shedding forth light and heat. The spots which we see so frequently flecking the dazzling surface are merely rents in the brilliant mantle, through which we are permitted to obtain glimpses of the comparatively non-luminous interior.

As the ability of the sun to warm and light this earth arises from the peculiar properties of the thin glowing shell which surrounds it, a problem of the greatest interest is presented in an inquiry as to the material composition of this particular layer of solar substance.

It is perfectly plain that it is not composed of any continuous solid material. It has a granular character which is sometimes perceptible when viewed through a powerful telescope, but which can be seen more frequently and studied more satisfactorily on a photographic plate. These granules have an obvious resemblance to clouds, and clouds, indeed, we may call them. There is, however, a wide difference between the solar clouds and those clouds which float in our own atmosphere. The clouds which we know so well are, of course, merely vast collections of globules of water suspended in the air. No doubt the mighty solar clouds do also consist of incalculable myraids of globules of some particular substance floating in the solar atmosphere. The material of which these solar clouds are composed is, however, I need hardly say, not water, nor is it anything in the remotest degree resembling water. Some years ago any attempt to ascertain the particular substance out of which the solar clouds were formed would at once have been regarded as futile, inasmuch as such a problem would then have been thought to lie outside the possibilities of human knowledge. The advance of discovery has, however, shed a flood of light on the subject, and has revealed the nature of that material to whose presence we are indebted for the solar beneficence. The detection of the particular element to which all living creatures are so much indebted is due to that distinguished physicist, Dr. G. Johnstone Stoney.

In the whole range of science, one of the most remarkable discoveries ever made is that which has taught us that the elementary bodies of which the sun and the stars are constructed are essentially the same as those of which the earth has been built. This discovery was, indeed, as unexpected as it is interesting. Could we ever have anticipated that a body ninety-three millions of miles away, as the sun is, or a hundred million of millions of miles distant, as a star may be, should actually prove to have been formed from the same materials as those which compose this earth of ours and all which it contains, whether animate or inanimate? Yet such is, indeed, the fact. We are thus, in a measure, prepared to find that the material which forms the great solar clouds may turn out to be a substance not quite unknown to the terrestrial chemist; nay, further, its very abundance in the sun might seem to suggest that this particular materal might perhaps prove to be one which was very abundant on the earth.

Carbon is one of the commonest as well as one of the most remarkable substances in nature. A lump of coke only differs from a piece of carbon by the ash which the coke leaves behind when burned. As charcoal is almost entirely carbon, so wood is largely composed of this same element. Carbon is indeed present everywhere. In various forms carbon is in the earth beneath our feet and in the air which we breathe. This substance courses with the blood through our veins; it is by carbon that the heat of the body is sustained, and the same element is intimately associated with life in every phase. Nor is the presence of carbon merely confined to this earth. We know it abounds on other bodies in space. It has been shown to be eminently characteristic of the composition of comets. But the greatest of all the functions of carbon in the universe has yet to be mentioned. This same wonderful element has been shown to be in all probability the material which constitutes those glowing solar clouds, to whose kindly radiation our very life owes its origin.

In the ordinary incandescent electric lamp the brilliant light is produced by a glowing filament of carbon. The powerful current of electricity experiences so much resistance as it flows through this badly conducting substance that it raises the temperature of the carbon wire so as to make it dazzlingly white hot. Indeed, the carbon is thus elevated to a temperature far in excess of that which could be obtained in any other way.

There is no known metal, and perhaps no substance whatever, which demands so high a temperature to fuse as does the element carbon. A filament of carbon, and a filament of carbon alone, will remain unfused and unbroken when heated by the electric current to the dazzling brilliance necessary for effective illumination. This is the reason why this particular element is so indispensable for our incandescent electric lamps. Modern research has now taught us that just as the electrician has to employ carbon as the immediate agent in producing the brightest of artificial lights down here, so the sun in heaven uses precisely the same element as the immediate agent in the production of its transcendent light and heat. Owing to the extraordinary fervor which prevails in the interior parts of the sun, all substances there present, no matter how difficult we may find their fusion, would have to submit to be melted, nay, even to be driven off into vapor. If submitted to the heat of this appalling solar furnace, an iron poker, for instance, would vanish into invisible vapor. In the presence of the intense heat of the inner parts of the sun, even carbon itself is unable to remain solid. It would seem that it must assume a gaseous form under such circumstances, just as the copper and the iron and all the other substances do which yield more readily than it to the fierce heat of their surroundings.

The buoyancy of carbon vapor is one of its most remarkable characteristics, accordingly immense volumes of the carbon steam in the sun soar at a higher level than do the vapors of the other elements. Thus carbon becomes a very large and important constituent of the more elevated regions of the solar atmosphere. We can understand what happens to these carbon vapors by the analogous case of the familiar clouds in our own skies. It is true, no doubt, that our terrestial clouds are composed of a material totally different from that which constitutes the solar clouds. The sun evaporates the water from the great oceans which cover so large a proportion of our earth. The vapor thus produced ascends in the form of invisible gas through our atmosphere until it reaches an altitude thousands of feet above the surface of the earth. The chill that the watery vapor experiences up there is so great that the vapor collects into little liquid beads, and it is, of course, these liquid beads, in countless myraids, which form the clouds we know so well.

We can now understand what happens as the buoyant carbon vapor soars upwards through the sun's atmosphere. They attain at last to an elevation where the fearful intensity of the solar heat has so far abated that, though nearly all other elements may still remain entirely gaseous, yet the exceptionally refractory carbon begins to return to the liquid state. At the first stage in this return the carbon vapor conducts itself just as does the ascending watery vapor from the earth when about to be transformed into a visible cloud. Under the influence of a chill the carbon vapor collects into a myraid host of little beads of liquid. Each of these drops of liquid carbon in the glorious solar clouds has a temperature and a corresponding radiance, vastly exceeding that with which the filament glows in the incandescent electric lamp. When we remember further that the entire surface of our luminary is coated with these clouds, every particle of which is thus intensely luminous, we need no longer wonder at that dazzling brilliance which, even across the awful gulf of ninety-three million of miles, produces for us the indescribable glory of daylight.—*Condensed from a Lecture by Sir. Robert Ball in the N. Y. Sun.*

THE BRIDGE OF AN OCEAN LINER.

Let us spend an hour with Captain Randle of the American liner, *St. Louis*, on the bridge in mid-ocean. He first takes us into the wheel house. It is a room about ten feet long and ten feet wide, with a curved front. A wheel about three feet in diameter is placed in the center of the room, and you are surprised to see that the quartermaster keeps turning it almost constantly. You have always thought that he had simply to keep his eye on the floating compass in the box directly in front of him and hold the ship steady in her course. As you look at the compass you see the ship veering now this way and now that as she rolls and plunges, or as one screw turns faster than the other, and thus pulls the ship around. It is hard to make two independent screws go at exactly the same speed, and so this man at the wheel is busy all the time turning the ship straight. He has to fight the waves and the screws and the winds at the same time, and he is a busy man.

This steering-wheel controls the ship by means of a small column of oil in a little tube. By turning the wheel this way or that the oil in the tube is forced up or down, and that opens or closes certain valves in the steam steering-gear four hundred feet away, and the rudder is turned as easily as if a child had done it. In most steamships the steam steering gear is controlled by hydraulic power—that is, by water—but the use of a column of oil is an improvement.

As you look about, you see fastened to the cornice directly in front of the wheel man, a little scale in black with white lines marked off on it. There is a dial on it, and as the ship rolls you see that this is a device to mark the degree of a roll. You may notice that it takes about a second for every degree of a roll. On each side of the room is another long, black gauge, and the dials point to certain figures, generally between ninety and ninety-five. These dials are little electrical devices, showing exactly how many revolutions the screws are making. The Captain, at a glance, knows what is going on in the engine rooms.

Over in the corner of the room is another curious electrical device. It is a little box with a clock in it. The Captain tells you it is the machine that controls the whistle in time of fog. The law requires a long blast of the whistle at such times every two minutes. By pressing in a button on this little clock apparatus, and by setting the clock in a certain manner, the whistle is blown automatically for seven seconds every minute. There can be no error of man in that work. Just as sure as every minute comes around that whistle will blow seven seconds. Under the old way, when a man pulled the whistle cord, there was no exactness in the work. When the fog is over the button is released, and the whistle stops. —*From Harper's Round Table.*

THE PAY OF MEMBERS OF CONGRESS.

The question of whether or not members of Congress should be paid and the amount and manner of payment, has been one which has provoked much argument and warm debate since the Union was formed. In his work, *The American Government*, Dr. B. A. Hinsdale treats this subject in an interesting manner:

The clause of the Constitution relating to this subject runs: "The Senators and Representatives shall receive a compensation for their services to be ascertained by law and paid out of the Treasury of the United States." At the time of the adoption of the Constitution, as now, members of Parliament received no compensation whatever, but, as Dr. Hinsdale points out, the objections to such a practice are, first, that the State has no more right to demand the services of citizens than to demand their property, without a just compensation, and, secondly, that it tends to exclude poor men from the lawmaking function. These objections ultimately caused the Federal Convention to agree that members of Congress should be paid, though it was urged by Dr. Franklin and Gen. Pinckney that Senators, at all events, since they would represent the wealth of the country, should receive no compensation, and a proposal to that end received the votes of five States. A question more earnestly contested was who should be the paymaster. Some delegates to the Convention contended that the members of the new Congress, like the members of the old one (under the Articles of Confederation), and especially that Senators, should be paid by the States. Those, on the other hand, who advocated payment by the nation, argued that it was unjust to ask the State to pay for services rendered to the nation; that the several States would compensate their members at different rates, thus begetting jealousy and heart-burning; and that some of the States might make the pay so low as to substitute for the question, "Who is most fit to be chosen?" "Who is most willing to serve?" Mr. Madison, moreover, pointed out that State payment would impair the very elements of coherence and stability in the Federal Government which they were seeking to infuse; Senators would become the mere agents of State interests and views, instead of being impartial guardians of the public good. Mr. Hamilton presented the same view in the tersest form: "Those who pay are the masters of those who are paid." These arguments were decisive of the source of payment. Another question arose, however, namely, whether the amount of the compensation should be fixed in the Constitution or be left to Congress. On the one hand, it was urged that the pay would need to be changed from time to time, and that it would be difficult or impossible to amend the Constitution; on the other hand, it was predicted that Congress would be likely to abuse the power. It was also proposed that Congress should fix the compensation only once in twelve years. The following amendment to the Constitution was submitted to the States in 1789, but failed to secure the requisite number of ratifications;

"No law varying the compensation for the services of the Senators and Representatives shall take effect before the election of Representatives shall have intervened." The matter was finally left unreservedly to the law-making power; that is to say, each Congress has absolute power over its own pay, subject to the Presidential veto. In every case of change no matter when made, it has had effect from the beginning of the Congress making it. In other words, every law on the subject has been retroactive. The law for instance, of March 16, 1816, reached back to March 4, 1815, the law of Aug. 16, 1856, to March 4, 1855; the law of March 3, 1873, to March 4, 1871, or two full years. It will be remembered that the law of 1873, known as the "Back Pay Grab." provoked severe criticism throughout the country, and the law of 1816 had a similar reception. In both cases it was the popular opinion that the increased compensation was excessive, and that the retroactive feature, although constitutional, was improper and incompatible with the character of Congress. In both cases, the Congress hastened to repeal the obnoxious legislation.

The compensation of members of Congress from the adoption of the Constitution to the present time is given as follows: From 1789 to 1815 they received \$6 a day; from 1815 to 1817 the pay was \$1,500 a year; from 1817 to 1855 it was \$8 a day; for the two years 1855, 1856, it was \$3,000 a year; from 1856 to 1871 it was \$5,000 a year; from March 4, 1871, to March 3, 1873, the pay was raised to \$7,500 a year, but since 1873 it has been \$5,000. Except in the period 1815-1817 members have always received mileage. Down to 1815 this was \$6 for every twenty miles of necessary travel going to and returning from the capital. From 1817 to 1865 it was \$8 for every twenty miles of such travel; that is to say, in 1860 a Senator from Oregon going to Washington and returning to his home by way of Panama would receive some \$3,000 mileage each way. From 1865 to 1871 the mileage was only twenty cents a mile. In 1871–1873 it was the actual expense of travel. Since 1873 it has been the same as it was from 1865 to 1871. The curious circumstance is noted that for the single year 1795 Senators received one dollar a day more than Representatives. We add that the Speaker of the house and the President *pro tempore* of the Senate receive each \$8,000 a year.

FOOLISH SUPERSTITIONS.

So serious a person as an undertaker laughed not long ago when some one told him the story of an old lawyer who had counted the number of carriages in a funeral procession, and had died three months afterward.

"That superstition does not influence men in my trade," he remarked briskly. "For years I have made a practice of counting the number of vehicles in every funeral line falling under my eyes, and I still live and am reasonably happy. When I am employed professionally, I have to learn by actual count whether the livery order has been filled; and whenever I see a line of carriages following a hearse, I run over the number from curiosity to find out how my rivals are getting on. All undertakers do it, and you know they are proverbially long-lived."

A similar comment was made by a clerk in a Western furnishing-store, when he was cautioned by a superstitious customer against opening an umbrella indoors.

"I have raised at least ten thousand umbrellas in this shop," he remarked contemptuously, "and I have stood under eight thousand of them at least, and if it has brought me bad luck, I have never known of it."

A hospital surgeon in a large city heard an old practitioner assert that accidents and diseases always occur in groups of three; and that he knew, as a matter of experience and observation, that if one boy broke an arm, and he was called to set it, two other similar cases would be certain to come up in the course of a few weeks; or that if he had one case of smallpox, he would be certain to have three.

"Join my staff at the hospital, doctor," replied the surgeon, "and you will soon be convinced that accidents and diseases are repeated in an unending series, and that your triple effect is a figment of the imagination. You would very soon abandon your rule of three, if you were to see, as I do, a hundred patients brought into the wards in the course of a week.

"Why, man," exclaimed the surgeon, "you are as foolish as the old women in New England who carried horse chestnuts in their pockets to keep off rheumatism, and would faint from fright when they had broken a looking-glass or spilled salt on the table; and as unreasonable as their husbands, who felt almost sure they ought to make their wills because they had seen the moon over the left shoulder, or had been numbered in a company of thirteen people. The world would be governed by a whimsical god of fantastic freaks and caprices if such trifles as these could determine human fortune or shorten human life."

That was a common-sense way of dealing with popular superstition. All such foolish notions tend to impair faith in an orderly and all-wise Providence.—*Youths' Companion.*

PHOTOGRAPHS BY THE MILE.

One hundred thousand photographs of actors, actresses, and celebrities every day is the record forced by the tobacco manufacturers who give away such things to purchasers. For a limited time one company alone had a demand for four hundred thousand pictures daily. At another time recently the representative of a large tobacco concern went to a photographer of New York and desired to place an order for one million cabinets, to be delivered in six months. The man who says "Now look pleasant" simply threw up his hands helplessly and said that he could not possibly print so many photographs in that time were the sun to shine every day and for twenty-four hours at a stretch. He confessed that he found his limit from one negative to be from ten to twelve prints a day; also that, increase his negatives as he might and spread his printing frames on every roof in his neighborhood as he might, he would still be simply paralyzed when it came to fixing, toning, washing, and mounting. And the picture-hungry man went to a place near by, where they could fill his order in ten days, where they print, develop, fix, wash, dry, and mount pictures by the mile—where in fact, they run them out by machinery at the rate of 100,000 a day on a pinch, and produce between 60,000 and 70,000 daily, all packed, regularly.

It is a marvel of modern photography. It is, as compared with the hand process, what the great latter-day inset printing presses, are to the old Washington hand presses, and it works not so very differently, for a great roll of sensitized paper more than 3,000 feet in length and three feet wide goes into one end of the apparatus untouched and comes out at the other end in the form of large, dry sheets of finished photographs. All this is managed with the utmost mechanical precision, and every picture is perfect when it emerges.

The process is a new one. Of course it acquires its value from the constantly increasing demand for immense numbers of photographs. Six or seven negatives of the regulation sort are placed in a frame, side by side, and the string of them thus formed is placed in the printing machine. A roll of bromide paper, prepared with a quick-acting emulsion, is suspended or pivoted at one end of the machine, and the end of the paper is started through. In the half-cylindrical exposure box, containing the negatives, an intense light is produced by means of eight incandescent electric lamps. When all is in readiness a platen below presses the paper up against the negatives, the light is turned on, and an exposure of one or two seconds is made. Instantly the lamps go out, the paper is pulled along by a winding-up device and the operation is repeated. When one or more of the negatives are less intense than their fellows and the ordinary exposure is found to be too long, thin sheets of waxed or tissue paper are pasted over, to filter the light rays and render them less active.

The roll of paper, upon which nothing appears, the impressions being all latent, is now carried to the developing, fixing, and washing tank, where it is again suspended and unwound as the process goes forward. The first compartment of the tank is provided with a developing solution, the next with water; then come hyposulphide of soda (fixative), water, alum, and more washing, until finally the broad ribbon goes into the drying box, hot air heated, up which it travels to the top floor, to be cut into sheets for easy handling. All the tanks are provided with sets of rollers, both at the top and bottom, and, as the tanks are three or four feet deep, the strip remains in each solution for several minutes, although it travels at a rate of about ten feet a minute. The process, so easily watched, is most remarkable. The lamps over the roll and developer tank are red or non-actinic, and under their glow the white paper enters the fluid over the first roller. When next it appears, to dive again, the half developed faces show dimly, and at the next emerging are strong, clear, and wonderfully uniform. Down, after a washing, goes the band into the "hypo," to come up cleared, and when at last the washed and alumed pictures go up the drying chute they are things of beauty and perpetual joys.

The possibilities of this automatic process are almost incalculable. It would be comparatively easy to take a flash-light photograph of the largest audience that ever assembled in any theatre at 9 o'clock, and then to hand every one a finished picture as he or she went out at the door when the play was done. In the case of the Defender-Valkyrie races a company could have placed at least 100,000 mounted photographs of the finish on the streets next day. It would easily be possible to produce 250,000 pictures every day. Of the large panel pictures the apparatus would then turn out 25,000 as a fair daily average. From any one single negative 20,000 finished cabinet photographs could be furnished each day—as against the twelve produced by the ordinary method.—*N. Y. Sun.*

RAISINS.

A Raisin Vineyard is in full bearing in three years, but the grape has not reached its perfection until the vine from which it springs is six or seven years old.

The Muscat and Thompson seedless are the best variety of raisin grape cultivated, the latter having only been introduced within the last few years, but the Zinfandell and Sultana have also large claims upon popularity.

Standing before one of these vines, upon which inverted cones of countless perfect spheres are hanging—each cluster weighing several pounds—a vision of the Hebrew spies, with their magnificent grapes of Eshcol, borne "on a staff between the two," rises before us, and involuntarily we exclaim, "Is not this also the Promised Land?"

About the 1st of September the long sunny days, the dewless nights, and the percolated soil have perfected their marvellous work, and the first crop is ready to be gathered. By this time the laterals have run riot, and the vineyardist can scarcely see over the top of his vines.

The process of grape-gathering for raisins requires the most delicate handling and cleanliness. Hundreds of shallow wooden trays, about five feet square, are distributed among dozens of trained pickers. The bunches are carefully cut from the vine and as carefully laid upon the base of the tray to avoid bruising them. There they remain untouched for ten days and nights. One-half of the grape is by this time cured: but instead of turning them by hand, an empty tray is placed over them, the lower one is inverted, and the turning and the transfer have been made. In twelve more days the curing is completed. The trays and contents are then stacked about twenty trays high, where they remain for five days sweating, when they are ready to be graded and packed in boxes of five, ten, twenty and fifty pounds for the Eastern market.

Vines six years old yield one and a half tons of raisins per acre, giving a net income of two hundred dollars per acre. While the supply of raisins is as unfailing as the growing demand, there is an æsthetic as well as an economic side. A few women have not only found raisin-vineyards a source of comfortable revenue, but their cultivation a most elegant and healthful pastime.

The approach to some of their homes, with the vineyard in the rear of the dwelling house, is through avenues of palm and magnolia trees, and if they lie, as many do, against the foothills of the Sierras, a ride through the columnar glories of giant red woods is a fitting introduction to the beauty and utility which is sure to be beyond.—*From Harper's Weekly.*

SOME QUEER BOATS.

Of all the uncommon forms that boats take, the newest, instead of being strange and complicated like most nineteenth-century inventions, are almost as simple as anything that floats. Only rafts of logs are more simple than what we call our "car-floats." They are the newest type of boats we know, and have come into being because New York City is on an island, with only a few railroads crossing to it from the mainland. The other great and little railways, which bring and take goods and people to and from New York, all stop on the opposite shores of our harbor, in New Jersey, Staten Island, and Long Island. Since the cars of one railroad often have to go past the city upon the other roads, these "floats" are used to transport them around our island, so that goods from Boston or Sag Harbor, for instance, can be sent around New York to the tracks of the roads that will carry them to San Francisco without unloading or reloading. The floats that carry these cars are merely boxes, the shape of great dominoes, with railroad tracks laid upon them. Some carry six freight-cars, some carry eight, and some carry ten cars. Tiny little propellers that we call "tug-boats" are warped or hitched alongside of these clumsy floating boxes, where they look as a little kitten would appear beside a big St. Bernard dog, or as a locomotive would look beside a house. But our queer, snorting, fussy little tug-boats march away with every floating thing to which they are hitched—even dragging hugh Atlantic steamships at their sides—because they reach down deep into the water, where their big screws, driven by very powerful engines, obtain a mighty hold. Because our tug-boats are so small, and yet so strong, they are able to move swiftly when they have no burdens to carry.

The "floats" that carry passengers around New York, so that they can go to Boston from Philadelphia or Chicago without changing cars (and even without getting out of bed on the sleeping cars), are not floats at all. They are very powerful and large steamboats, with decks covered with iron plates, with car tracks on these decks, and with arrangements for locking the car wheels fast to the tracks, so that no matter how boisterous the water may be on stormy days, the cars cannot break loose and roll overboard. We have several queer sorts of boats and other floating objects that look like floating houses. Among them are what we call our floating baths, and our floating docks, and our cattle and ice barges. But there is one kind of floating building that looks like a tower or a steeple riding the waters and steering itself around. That strange thing—and we employ many such—is a floating grain elevator. It is a tall four-sided tower built upon a square snub-nosed boat. It has a great proboscis, that it sticks down into canal-boats full of grain, which it sucks or dips out so that it can load the grain into the holds of ships that are to carry it to Europe.—*From Harper's Round Table.*

ENGINEERING TOOLS AT POMPEII.

Under the title of "Things of Engineering Interest Found at Pompeii," Professor Goodman lately gave his inaugural lecture in the engineering department of the Yorkshire College, Leeds. The lecturer remarked that he had recently visited Pompeii, and was not only charmed by the great beauty of the works of the ancient Romans, but also by their extreme ingenuity as mechanics—in fact, it was a marvel how some of the instruments and tools they were in the habit of using could possibly have been made without such machinery as we now possess.

After explaining the situation and destruction of Pompeii by showers of ashes and mud, not lava, as is usually supposed, in the year 79 A. D., Professor Goodman showed a series of about fifty lantern slides, prepared from photographs taken by himself in Pompeii last Easter. The streets, he explained, were used as waterways to carry off the surface water, and probably sewage, from the houses. The pavements were raised about a foot above the streets, and stepping stones were provided at intervals for foot passengers.

The horses and chariot wheels had to pass between, and in many places deep ruts have been worn by the chariot wheels in the stone paved streets. The water supply of Pompeii was distributed by means of lead pipes laid under the streets. There were many public drinking fountains, and most of the large houses were provided with fountains, many of most beautiful design. The amphitheater, although a fine structure, capable of seating 15,500 people, was small compared with many in Italy. The bronzes found at Pompeii reveal great skill and artistic talent. The bronze brazier and kitchener were provided with boilers at the side and taps for running off the hot water. Ewers and urns have been discovered with internal tubes and furnaces precisely similar to the arrangement now used in modern steam boilers. Several very strong metal safes, provided with substantial locks, have been found. The locks and keys were most ingenious, and some very complex. On looking at the iron tools found in Pompeii, one could almost imagine he was gazing into a modern tool shop, except for the fact that the ancient representatives have suffered severely from rust.

Sickles, billhooks, rakes, forks, axes, spades, blacksmith's tongs, hammers, soldering irons, planes, shovels, etc., are remarkably like those used to-day; but certainly the most marvelous instruments found are the surgical instruments, beautifully executed, and of design exactly similar to some recently patented and re-invented. Incredible as it may appear, yet it is a fact, that the Pompeiians had wire ropes of perfect construction.—*Scientific American.*

THE RIGHT PHILOSOPHY.

It is worth while for us all, even when suffering pain, to refrain from frowning and wrinkling up our faces, and saying impatient words. Every passing thought and feeling write themselves upon the countenance, and the young girl is making day by day not only the woman she will be in character later on, but the woman she will be in looks. Handsome or plain, agreeable or the opposite, the woman of forty is dependent for her looks on the girl of fourteen. You owe an amount of thought and consideration to the woman you are going to be, and the friends who will love her, and so you must not let needless lines and furrows come to your pretty brows, but keep your foreheads smooth, and do not draw your lips down at the corners nor go about looking unhappy. It is possible, even when bearing much pain, to wear a tranquil expression if one will, but remember that the tranquil mind in the end can conquer pain.

Crossing town the other day in haste to catch a train, the horse-car was three times blocked by great vans which stood upon the track. I looked about on my fellow-passengers. Some had flushed and angry faces, some could not sit still, but tapped the floor with their feet, and uttered exclamations, and looked at their watches. One or two stepped out with their bags and walked hastily onward. But a dear old lady in the corner of the car was a pattern of sweetness and amiability, and I heard her observe to her neighbor: "We will probably lose our train, but at this time of day there are trains every half hour, and it's never well to be put out by little accidents of this sort." She had the right philosophy. —*From Harper's Round Table.*

WHAT SHALL WE EAT?

A pamphlet issued under the auspices of the United States Department of Agriculture, prepared by W. O. Atwater, Ph. D., professor of chemistry in Wesleyan University, on the nutritive value of food products, says:

"A quart of milk, three-quarters of a pound of moderately fat beef—sirloin steak, for instance—and five ounces of wheat flour all contain about the same amount of nutritive material; but we pay different prices for them, and they have different values for nutriment. The milk comes nearest to being a perfect food. It contains all the different kinds of nutritive materials that the body needs. Bread made from the wheat flour will support life. It contains all of the necessary ingredients for nourishment, but not in the proportions best adapted for ordinary use. A man might live on beef alone, but it would be a very one-sided and imperfect diet. But meat and bread together make the essentials of a healthful diet. Such are the facts of experience. The advancing science of later years explains them. This explanation takes into account, not simple quantities of meat and bread and milk and other materials which we eat, but also the nutritive ingredients or 'nutrients' which they contain."

The chief uses of food are two: To form the material of the body and repair its wastes; to yield heat to keep the body warm and to provide muscular and other power for the work it has to do. Dr. Atwater has prepared two tables showing, first, the composition of food materials, the most important of which are the nutritive ingredients and their fuel value; second the pecuniary economy of food, in which the amount of nutrients is stated in pounds. In the first table we find that butter has the greatest fuel value, fat pork coming second, and the balance of the foods mentioned being valued as fuel in the following order: Cheese, oatmeal, sugar, rice, beans, cornmeal, wheat flour, wheat bread, leg of mutton and beef sirloin, round of beef, mackerel, salmon. Codfish, oysters, cow's milk, and potatoes stand very low as fuel foods.

From the second table we learn that the greatest nutritive value in any kind of food of a specified value (Dr. Atwater takes 25 cents' worth of every kind of food considered) is found in cornmeal. In 10 pounds of cornmeal there are a trifle more than 8 pounds of actual nutriment. In 8½ pounds of wheat flour there are over 6¼ pounds of nutriment; in 5 pounds of white sugar there are 4¼ pounds of nutriment; in 5 pounds of beans there are 4 pounds of nutriment; in 20 pounds of potatoes there are 3¾ pounds of nutriment; in 25 cents' worth of fat salt pork there are 3½ pounds of nutriment; in the same value of wheat bread there are 2¼ pounds, in the neck of beef, 1½ pounds, in skim milk cheese, 1½ pounds; in whole milk cheese, a trifle more than 1½ pounds; in butter, 1½ pounds; and in smoked ham and leg of mutton about the same; in milk, a trifle over 1 pound; in mackerel, about 1 pound; in round of beef, ¾ of a pound; in salt codfish and beef sirloin, about ½ a pound; in eggs at 25 cents a dozen, about 7 ounces; in fresh codfish, about 6 ounces; and in oysters at 35 cents a quart, about 3 ounces.

PEDICULOSIS.

Every child who attends a public school, or is thrown into similarly miscellaneous company, is liable to the distressing affection known as lice, or in medical parlance as "pediculosis," which is perhaps a more euphonious term.

Cleanliness is the greatest safeguard against contagion of every kind, and lice will not breed generally except in conditions of more or less neglect. Yet the familiarity with which children meet in the school-room and on the playground is sufficient excuse for the transmission of pediculosis from one child to another.

Pediculosis is usually easy of recognition during its earlier stages, but it is so unlooked for and insidious in its establishment that often it is only after a sufficient time has elapsed for the aggravated symptoms to appear that treatment is begun. These later signs are by no means so unimportant as might at first be imagined.

The insect which distinguishes this disease from all others is poisonous in its nature, and it is possible by the simple act of scratching to bring on a general irritation of the skin in any part of the body. This irritation may appear to the inexperienced person to be an entirely distinct and unexplained affection.

The treatment of pediculosis is simple enough at any stage. The first thing, of course, is to get rid of both the insects and the spores, or nits. To do this about four ounces of crude petroleum are required. This can be purchased of any druggist. Pour one-quarter of the liquid carefully into the hair for four successive days, allowing it to remain for four or five hours. The hair must be carefully washed out with warm soapsuds and thoroughly dried after each treatment.

Probably every sign of insects and nits will have disappeared by the fourth day. If any nits should remain entangled in the hair, they may be washed out with a little vinegar.

This method is much better than the fine-tooth comb of our grandparents, since there is no danger of irritating the scalp. In aggravated stages of pediculosis the same treatment is necessary. The swollen glands and the eruptions on the skin will disappear as soon as the source of contagion is removed. A little simple ointment, say what is known as "boracic," rubbed on the skin over the swellings and raw surfaces, will hasten recovery.—*Youth's Companion.*

SHORTSIGHTEDNESS.

Myopia or shortsightedness being essentially a condition due to abuse of the eye, one is constantly obliged to say "don't" to patients. It occurs to me that it might be useful to put these prohibitory rules in aphoristic form:

1. Don't read in railway trains or vehicles in motion.
2. Don't read lying down or in a constrained position.
3. Don't read by firelight, moonlight, or twilight.
4. Don't read by a flickering gaslight or candlelight.
5. Don't read books printed on thin paper.
6. Don't read books which have no space between the lines.
7. Don't read for more than fifty minutes without stopping, whether the eyes are tired or not.
8. Don't hold the reading close to the eyes.
9. Don't study at night, but in the morning when you are fresh.
10. Don't select your own glasses at the outset.

It would almost seem as though some of these rules were too obvious to require mention, but practical experience shows that myopes abuse their eyes just in the way stated. Reading by firelight or by moonlight are favorite sins. Readin lying down tends to increase the strain on the accomodation, and while traveling tires the ciliary muscle because of the too frequent adjustmet of focus. In short, anything which tends to increase the quantity of blood in the organ favors the increase of the defect, leading in extreme cases to detachment of the retina and blindness.—*Dr. G. Sterling Ryerson of Trinity Med. College in The Canada Lancet.*

ACTION OF THE RAIN.

The rain falling on the rocks sinks into every crack and crevice, carrying with it into these fissures surface material which has been degraded by the weather, and thus affording a matrix sufficient to start the growth of vegetation, and afterward to maintain the plants. The fibers and roots of these plants, bushes, and trees thus brought into life, growing and expanding, act as wedges to split up the surface of the rock and to commence the process of wearing away. From this quality of destruction a large class of plants derive the name of Saxifrages, or rock breakers, from their roots penetrating into the minute fissures in search of water, and so assisting in the process of disintegration. In winter the water collected in the hollows and crevices becomes frozen, and expanding as it changes into ice, acts like a charge of blasting material in breaking up the rocks. The pieces thus detached become further disintegrated by frost and weather, and, being rolled over and over and rubbed against each other as they are carried away down the mountain currents, are ground gradually smaller and smaller, till from fragments of rocks they become bowlders, then pebbles, and finally sand. As the mountain stream merges into the river the pebbles and coarse sand continue to be rolled along the bottom of the channel, while the argillaceous particles and salts become mingled with the water, and flow on with it either in suspension or solution.—*Longman's.*

MINING MACHINE.

No. 547,896. Henry H. Bliss, Washington, D. C. *Patented Oct. 15th*, 1895. Fig. 1 is a side view partly in section; Fig. 2 is a top view with the motor removed; and Fig. 3 is an end view. This machine is to be driven by an electric motor, and the object of this improvement is to automatically graduate the feed, so that the strain upon the motor will be constant. In using electric motors it is necessary to run the armature at a constant speed. If the speed falls below the normal, the efficiency of the machine falls off greatly, and there is also great danger of burning out some part of the machine. In undercutting coal, the cutters are very liable to encounter hard streaks, sulphur balls, etc., which impose heavy work on the motor and reduce its speed. In this machine the pressure upon the cutters is varied to suit the hardness of the material which the cutters are working in. The cutter bar *D* is rotated by means of a chain 2, and a sprocket wheel on the rear shaft *K*, which is connected by suitable gears to the armature shaft *H'*. The working parts are all mounted on a frame *B* which slides within the stationary frame *A*. The sliding frame is fed forward by means of a

piston, that is to the pressure existing at that moment in the engine cylinder. The wheel will partly slide and partly roll, on the surface of the drum as it revolves back and forth, the amount of the rolling motion depending upon the angle to which the wheel is turned. A pair of counting wheels *m* are provided to register the revolutions of the wheel *D*. When in operation, the piston rises and swivels the wheel, and the drum *A* turns back and forth, at each stroke. During the forward stroke, the wheel measures the power exerted by the steam pressure, and during the return stroke it runs backward and deducts the resistance due to the back pressure. It thus records on the registering wheels, the net power exerted upon the piston of the engine, and adds the successive strokes together, showing at all times the net sum of the power exerted, during the time it was in operation.

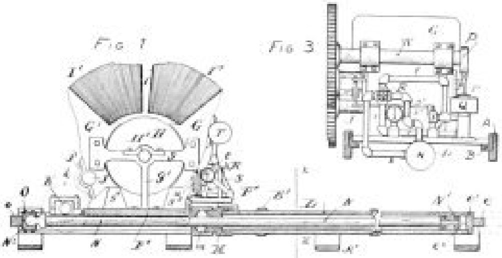
PUMP FOR GRITTY WATER.

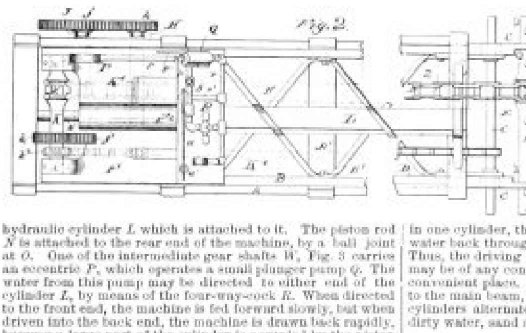
No. 547,576. Albert G. Fuller and Barton H. Coffey, New York, N. Y. *Patented Oct. 8th*, 1895. Fig. 4 is a section through one half of the pump; and Fig. 3 is a section along the line *X* of Fig. 4, and on a smaller scale. Two pumps are employed, one on each side of the centre line *X*, and the piston rods are coupled to a beam *Z*, which is supported upon the A frame *J*. The beam serves only to couple the pistons, not to drive them. The pistons move loosely in a brass cylinder or liner *E*, which can be easily removed. The pistons are driven downward by means of clean water, which is forced in through the pipe *H*, and valve *G'*, by a common direct steam pump of any kind. When the piston descends

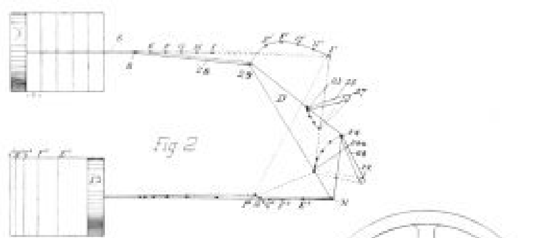
The dirty, sandy water is expelled through the pipe *L*, into the air chamber 3, and out through the discharge pipe *M'*. The clack valves *N*, are hung loosely on their centers, so that they can tilt over any rubbish that may lodge on their seats, and they are hung upon crank arms *N'*, by which they may be slid across their seats at any time, to free them from obstructions, as shown at 5.

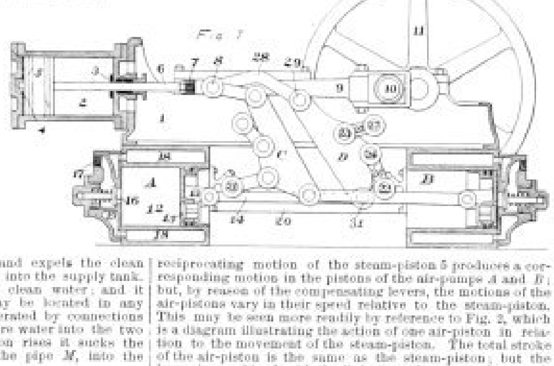
COMPENSATING PUMPING ENGINE.

No. 547,558. Albert P. Massey, Watertown, N. Y. *Patented Oct. 8th*, 1895. Fig. 1 is a vertical section of the engine cylinder and pumps; Fig. 2 is a diagram showing the modification of the power of the steam piston, by the compensating mechanism. The object of the improvement is to permit the steam to be cut off at three eighths stroke, or earlier, and to so apply the power that the air may be properly compressed in the pumps, without depending upon the fly wheel. The fly wheel serves only to enable the crank to pass the centre properly. The steam-piston is operatively connected to the air-pistons by the compensating levers *C* and *D*. The lever *D* is suspended at two points 23 and 24 by the links 25 and 26. Link 25 is attached to the frame by pin 27, about which it is free to revolve. Link 26 is attached to the frame by the pin 22, about which 26 is free to revolve. The upper end of lever *D* is connected to the cross-head pin 8 by the connecting-rod 28 and pin 29. It is connected to the air-piston 13 by the connecting-rod 14 and pin 31. Lever *C* is connected in a similar manner to transmit power from cross-head pin 8 to the piston of air-pump *E*. In operation the





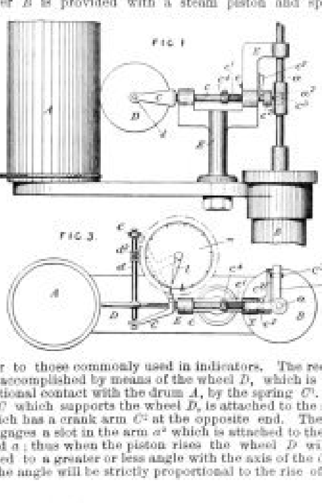




hydraulic cylinder *L* which is attached to it. The piston rod *N* is attached to the rear end of the machine, by a ball joint at *O*. One of the intermediate gear shafts *W*, Fig. 3 carries an eccentric *P*, which operates a small plunger pump *Q*. The water from this pump may be directed to either end of the cylinder *L*, by means of the four-way-cock *R*. When directed to the front end, the machine is fed forward slowly, but when driven into the back end, the machine is drawn back rapidly, because a large part of the cylinder is occupied by the piston rod, and the area of the piston is therefore much smaller. All of the water which is delivered by the pump is forced through a by-pass valve *S*, which is closed by an adjustable spring. If the cutters strike hard stuff, so that th pressure in the feed cylinder rises above the proper amount, the water lifts the valve and escapes into the suction pipe. Thus the pressure upon the cutters is never allowed to become so great as to reduce their speed and check the motor. If they encounter soft stuff, they are fed forward correspondingly faster, so that the load upon the motor is made practically uniform.

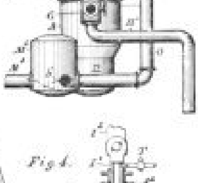
POWER METER.

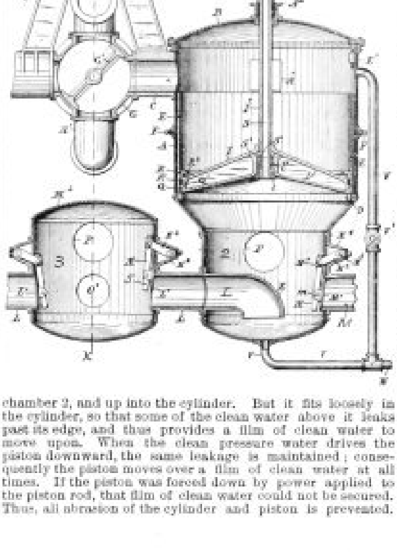
No. 546,897. William G. and Charles W. Little, Heckington, England. *Patented Sept. 24th*, 1895. Fig. 1 is a side view; and Fig. 3 is a top view of the instrument. This meter is designed to record the power which is exerted in the cylinder of a steam engine, and to register the amount, continuously. It resembles a common "indicator" in many particulars. The drum *A* is rotated by a cord which is attached to some reciprocating part of the engine; and the cylinder *B* is provided with a steam piston and spring,



similar to those commonly used in indicators. The recording is accomplished by means of the wheel *D*, which is held in frictional contact with the drum *A*, by the spring *C'*. The fork *C* which supports the wheel *D*, is attached to the shaft *C*, which has a crank arm *C²* at the opposite end. The pin *C³* engages a slot in the arm *a²* which is attached to the piston rod *a*; thus when the piston rises the wheel *D* will be swiveled to a greater or less angle with the axis of the drum *A*. The angle will be strictly proportional to the rise of the

in one cylinder, the other piston rises and expels the clean water back through the lower pipe *H'*, into the supply tank. Thus, the driving pump handles only clean water; and it may be of any convenient size, and may be located in any convenient place. The valve *G'*, is operated by connections to the main beam, and turns the pressure water into the two cylinders alternately. When the piston rises it sucks the dirty water, sand and stones through the pipe *M*, into the



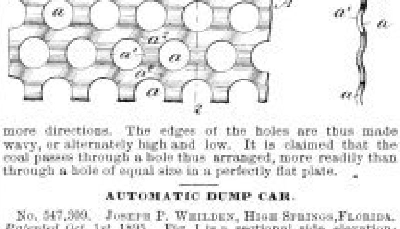


chamber 2, and up into the cylinder. But it fits loosely in the cylinder, so that some of the clean water above it leaks past its edge, and thus provides a film of clean water to move upon. When the clean pressure water drives the piston downward, the same leakage is maintained; consequently the piston moves over a film of clean water at all times. If the piston was forced down by power applied to the piston rod, that film of clean water could not be secured. Thus, all abrasion of the cylinder and piston is prevented.

reciprocating motion of the steam-piston 5 produces a corresponding motion in the pistons of the air-pumps *A* and *B*; but, by reason of the compensating levers, the motions of the air-pistons vary in their speed relative to the steam-piston. This may be seen more readily by reference to Fig. 2, which is a diagram illustrating the action of one air-piston in relation to the movement of the steam-piston. The total stroke of the air-piston is the same as the steam-piston; but the lever is combined with the links in such manner that a uniform horizontal motion of the upper end of the lever to right will give a constantly-decreasing motion to the lower end of the lever to the left. In the beginning of the stroke the virtual fulcrum of the lever is at 23, and link 26 serves merely as a guide. In the latter portion of the stroke the pin 24 is the fulcrum and link 25 is a guide. In intermediate positions the virtual fulcrum is a point somewhere between the pins 23 and 24. The paths described by the two ends of the lever are indicated on the drawings; also, the position of the centers for each fifth of the stroke of the steam-piston. The spaces into which the cylinders are divided, show the volumes swept by the air-piston compared with the volumes swept by the steam-piston during each one-fifth of its stroke. If steam were admitted to the steam-cylinder full stroke, the pressure per square inch would be uniform, and the pressure per square inch of the air-piston would be inversely as the volumes swept by the air-piston at any part of the stroke. This would give a pressure of air, much higher than that of the steam which was used to drive the machine.

SCREEN SEGMENT.

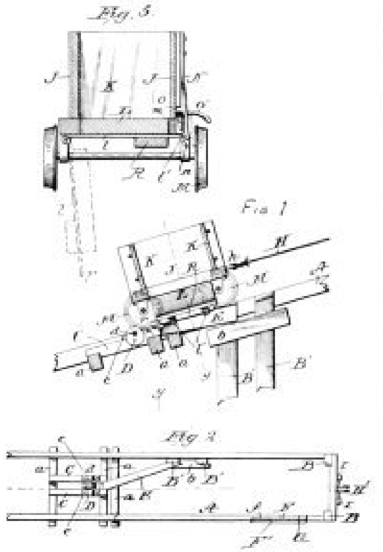
No. 547,140. George W. Cross, Pittston, Penna. *Patented Oct. 1st*, 1895. Fig. 1 shows the top surface of this improved screen plate, and Fig. 2 shows a cross-section of the same. The plate is corrugated between the holes, in two or



more directions. The edges of the holes are thus made wavy, or alternately high and low. It is claimed that the coal passes through a hole thus arranged, more readily than through a hole of equal size in a perfectly flat plate.

AUTOMATIC DUMP CAR.

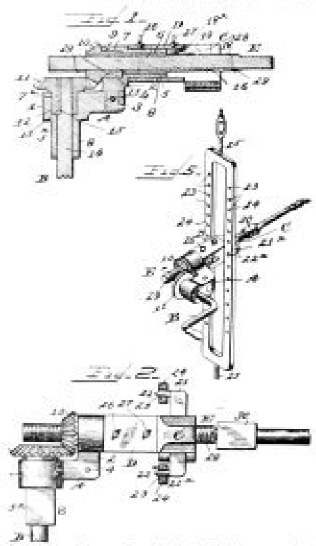
No. 547,360. Joseph P. Weilden, High Springs, Florida. *Patented Oct. 1st*, 1895. Fig. 1 is a sectional side elevation; Fig. 2 is a top view of the track; and Fig. 5 is a cross section of the car. The car bottom is hinged to the side sills as shown in Fig. 5, and when it is closed, is held in place by a spring catch *N*, which is attached to the side of the car. The catch is opened, to dump, by means of a rock shaft *O*, having a finger *M*, and an arm *O'*. As the car reaches the place to dump, the arm *O'* encounters an inclined block which forces it upward, and thus releases the bottom door. The door then hangs downward as shown by dotted lines in Fig. 5. When the car starts back, the door encounters the diagonal bar E, between the rails, and as it moves along the door is partially closed. As the car proceeds, the door glides off the bar E



onto the eccentric roller D, shown in Fig. 1. The roller turns over by friction with the door, and the part having the greatest radius crowds the door upward until the latch secures it. As soon as the car passes, the heavy side of the roller drops down again, so that it is out of the way of the next advancing car. Thus the car door is automatically closed and latched.

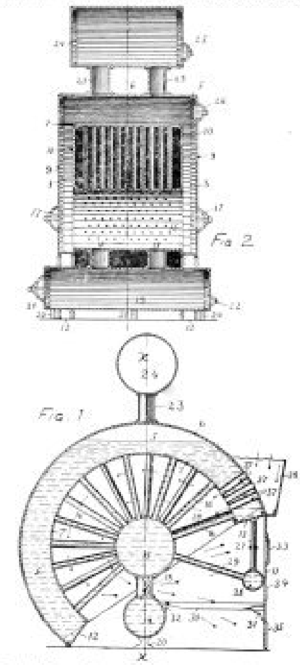
MINING DRILL.

No. 546,008. Joseph E. Hart, Briceville, Tenn. *Patented Sept. 10th, 1895.* Fig. 1 is a section through the bracket and gears; Fig. 2 is a top view; and Fig. 5 shows the machine in position for work. The object of this device is to change the speed of the drill readily, without extra gears. Each arm of the bracket 8 is made square to fit into the square coupling box D. Each gear 10 and 11 is provided with a feather, and has a central hole which exactly fits the drill spindle E. The crank shaft B fits in either gear equally well. When it is desired to change the speed of the drill, the crank shaft is pulled out of its gear, the set screw 26 is slacked off, and the entire bracket with the gears, is slipped off over the end of the spindle. The spindle is then entered into the hole in the other arm of the bracket, the bracket is shoved up into the box D and made fast. The proportions of the gearing are thus reversed. The crank is then inserted and the machine is ready to go ahead. The feed nut is made in halves in the usual manner, and is coupled to the box D by a set-screw 27. The lower half of the nut has two arms 21 provided with prongs 22, which enter holes in the drilling post, and thus support the machine in working position, as shown in Fig. 5.



STEAM BOILER.

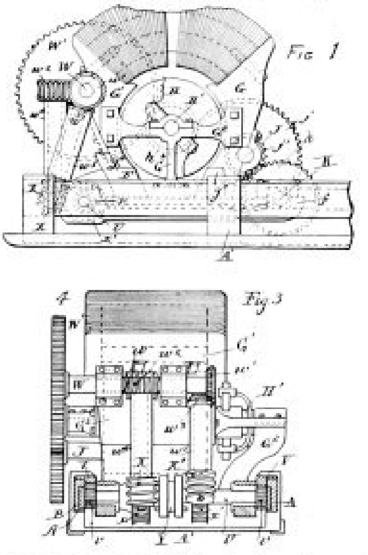
No. 546,786. James J. Rohan, St. Louis, Mo. *Patented Sept. 24th, 1895.* Fig. 1 is a vertical section from front to back of the boiler; and Fig. 2 is a vertical section along the line x of Fig. 1. The body of the boiler consists mainly of two cylindrical shells 6 and 7, which comprise a little more than half a circle. The inner shell 7 is closed by end plates 10, and the outer shell is similarly closed by the heads 9. The water spaces thus enclosed between the heads 9 and 10 are connected, not only by the space 5, but by the central drum 15. Water tubes 16 connect this drum with the inner shell 7. A small water drum 28 is suspended at the front, by the pipes 27. A series of water tubes 29 connect the drums 28 and 15, and constitute a "water grate." The fire which is maintained on this grate burns downward, the hot gases passing through the grate in the direction of the arrows. The combustion chamber is closed at the top by tiles 36 which rest on the last row of tubes 16. The whole surface of the inner shell, and the end heads 10, are good heating surfaces, and the water tubes are very effective, because they



extend at right angles with the current of hot gases. The smoke and spent gas escape through short fire tubes 37 into the smoke box 38. An ordinary grate 30, resting at one end on the mud drum 19, is provided, when it is desired to fire in the ordinary manner.

FEED FOR MINING MACHINES.

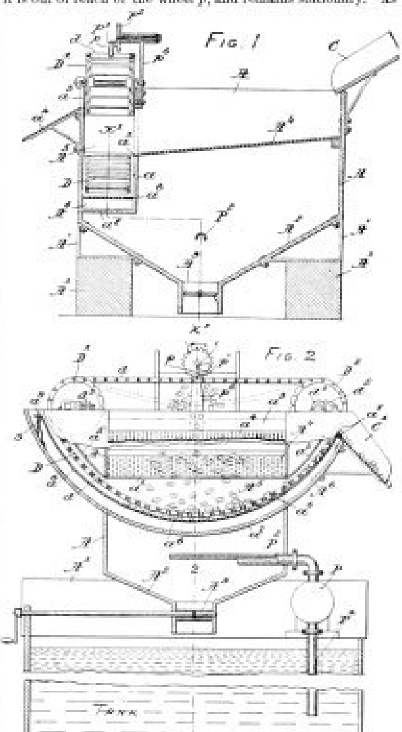
No. 547,837. Henry H. Bliss, Washington, D. C. *Patented Oct. 15th, 1895.* Fig. 1 is a side elevation; and Fig. 3 is a rear end view. The feed mechanism here shown is adapted to any variety of machine which carries a rotating cutter bar at the front end of the sliding frame. The motor and all of the working parts are attached to the sliding frame which is moved forward upon the stationary frame, by means



of racks V, pinions v, and shaft U. The forward movement is obtained by means of the shaft W (which is geared to the motor) and the worms and wheels w, w, and X, x. The backward motion is made by means of the gears w', w', and the worm and wheel X', x'. Both wheels x, x' run loose on the shaft U, and either may be coupled to the shaft by means of the clutch Y.

COAL JIG.

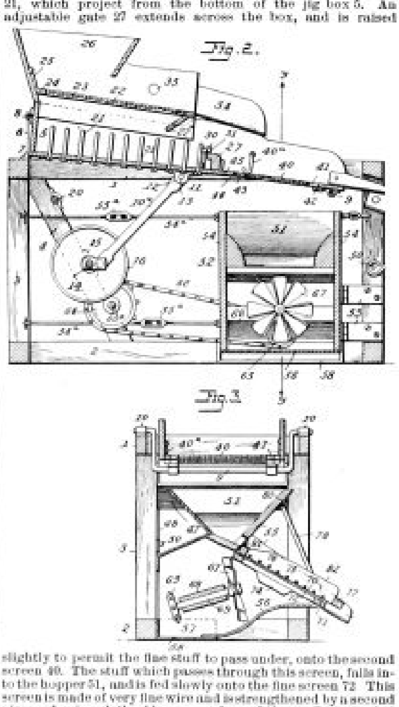
No. 547,129. David E. Phillips, Mahanoy City, Penna. *Patented Oct. 1st, 1895.* Fig. 1 is a vertical section on the line 2 of Fig. 2, and Fig. 2 is a cross-section on the line x' of Fig. 1. The coal which is to be cleaned is fed from the spout C, onto the perforated plate A^4. The water is pumped in by jerks by the pump P, and passes upward through the plate and lifts the mass of coal and slate at each stroke. The coal rapidly works to the top and passes off through the notch a^2, with the water. The delivery chute a^4, is perforated and the water drains back into the tank to be used over again. The slate and rubbish accumulates in the bottom of the circular pocket A^5, and is removed therefrom by the conveyor D. This conveyor is driven intermittently by means of a finger attached to the rotating wheel p. The circular pocket is provided with a false bottom a^6, of bronze, which is hinged at the edge of the slate chute c^1, and is supported by springs s, at a^7. So long as there is not enough weight of slate, etc., on the plate a^6, to depress the springs, the upper run of the conveyor d, sags as shown by the dotted lines, consequently it is out of reach of the wheel p, and remains stationary. As



soon as a^6 sinks downward, the upper run straightens out and engages the driving wheel, and the conveyor is thus driven until the slate is removed from the pockets. The conveyor is thus made automatic in operation.

CONCENTRATOR.

No. 544,828. George M. Reed, Waltham, Mass. *Patented Aug. 20th, 1895.* Fig. 2 is a vertical section taken lengthways of the machine; and Fig. 3 is a cross section on the line y y of Fig. 2. The crushed ore is fed into the hopper 26, and and falls on the coarse screen 22. The coarsest lumps which fail to pass through, work off the end of the screen and into the chute 34. The material which passes through is broken up and divided by means of a series of upright pins 21, which project from the bottom of the jig box 5. An adjustable gate 27 extends across the box, and is raised



slightly to permit the fine stuff to pass under, onto the second screen 40. The stuff which passes through this screen, falls into the hopper 51, and is fed slowly onto the fine screen 72. This screen is made of very fine wire and is strengthened by a second piece of wire cloth of larger mesh, and the stuff is retarded upon the screen by the riffles 76. This screen, and the jig box 5 are hung on swing links and, are vibrated by means of pitmen which connect to cranks on the shaft 14. The final separation is performed by an air blast, which is generated by the fan wheel 67. The fine concentrates pass down the incline 56 into the pan 58.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 6. SCRANTON, PA., JANUARY, 1896. WITH WHICH IS COMBINED THE MINING HERALD

Written for THE COLLIERY ENGINEER AND METAL MINER.

PROSPECTING FOR PLACER GOLD.

A NOVEL AND GIGANTIC SCHEME IN CLEAR CREEK CANYON, COLORADO.

Showing how Gold is Obtained on a Large Scale from Gold Bearing Gravels under Favorable Conditions.

(By Prof. Arthur Lakes, Golden, Colo.)

[CONCLUDED FROM NOVEMBER, 1895.]

In the November issue we gave a full description of the plant of the Roscoe placer up to date. Fig. 1, which we herewith present, shows a view of the last and biggest undercurrent which was omitted from that article for want of space. On a recent visit we find yet some more improvements. A derrick planted on the bank worked a small steam engine to hoist the enormous boulders out of the pit by placing them on a truck, on an inclined plane, which is also hoisted up to a level by a wire rope from the engine passing over a wheel at the head of the inclined plane. The miners had just reached bed rock and imbedded in it the box to catch the debris blown down by the great nozzles (See Fig. 2.) This box is sunk into bed rock forming a receiving trough, as shown in the sketch. There the water is forced up through the Ludlum water elevator; and the sand, rocks and gold are driven up through the Ludlum gravel elevator with its funnel like pipe by a small giant imbedded in bed rock a few feet below the end of the elevator. The elevators as seen in the sketch are supplied with water power force by pipes let down at a steep angle from the main pipe on the bank.

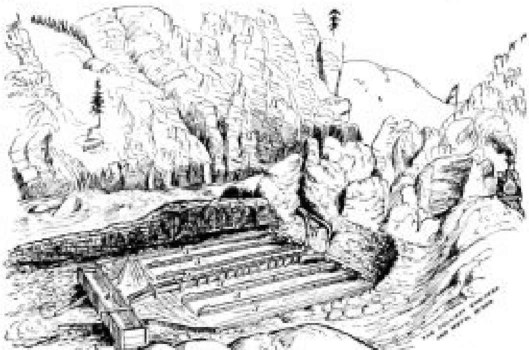


FIG. 1. LAST AND BIGGEST UNDERCURRENT SLUICE.

1, FLUME FROM UPPER UNDERCURRENT; 2, FLUME CARRYING COARSE MATTER; 3, BOXES LINED WITH BURLAP.

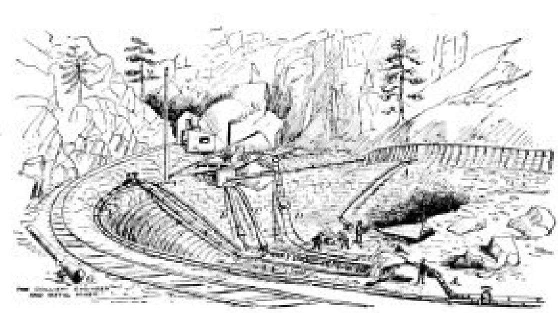


FIG. 2. LATEST VIEW OF ROSCOE PLACER.

A, A, GIANTS; *B*, LUDLUM'S GRAVEL ELEVATOR; *C*, WATER ELEVATOR; *D*, STONES HOISTED UP TRAMWAY BY STEAM ENGINE *E*; *F*, BOX OR TROUGH TO GUIDE MATERIAL TO ELEVATORS; *G*, AN ELEVATOR PIPE.

The Roscoe placer and other placers in Colorado will soon have to go into winter quarters and cease work for the winter till next spring, owing to ice forming on the streams.

Passing up the stream from the Roscoe placer we see numerous small parties engaged in placer mining on a small scale, some with the rocker or cradle and long-tom and small sluices as shown in Figs. 3 and 4.

The "rocker" is a box forty inches long, sixteen inches on the bottom, one foot high, with sides sloped like a cradle, and rockers at middle and back end. The upper end is a hopper twenty inches square with half-inch diameter holes. The top hopper is removable. Under the perforated plate is a light frame, placed on an incline, upon which a canvas apron is stretched, forming a riffle. In washing with a rocker, the material is thrown into the hopper, water poured on with a dipper held in one hand while with the other the cradle is kept rocking. The water washes the sand and dirt through the bottom of the hopper, and gold or amalgam is either caught in an apron or picked up in the bottom of the rocker, while the sand and lighter material are discharged at the end, and the coarse material in the hopper is thrown aside. In California, rockers were used before ditches came into use; now they are used in cleaning up placer claims and quartz mills, for collecting finely-subdivided particles of amalgam and quicksilver.

The "log tom," or "tom," was imported from Georgia. It was first used in Nevada County in 1849. It is a rough trough twelve feet long, fifteen inches to twenty inches wide at top, thirty inches at the lower end, and eight inches deep. It is supported on timbers or stones and set on an incline of twelve inches, or one inch per foot. A sheet-iron plate, perforated with holes half an inch in diameter, forms the bottom of the lower end of the trough, which is beveled on the lower side so as to have the plate on a level. Material, when fed in from sluices, on striking the riddle or perforated plate, is at once sorted, fine dirt, with water, passing through it, while coarser stuff is shoveled off. Under the perforated plate is a flat box, set on an incline, into which finer gravel passes. By continual discharge of water through the plate, and occasional aid the of shovel, the sand is kept loose, allowing gold to settle. The "tom" disappeared with the arrival of sluices.

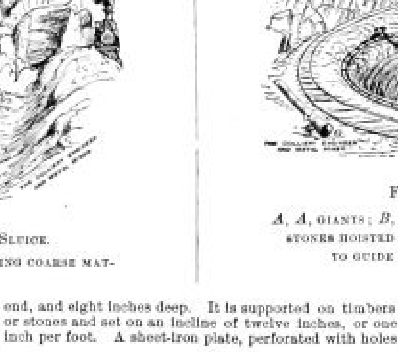


FIG. 3.—ROCKING GOLD.

1, BOX LINED WITH PERFORATED COPPER SHEET; 2, BOX LINED WITH WOODEN SLAT RIFFLES; 3, ROCKERS.

The "puddling box" is a box six feet square, eighteen inches deep, arranged with plugs for discharging contents. The box is filled with water and clayey dirt containing gold. By stirring with a rake the clay is dissolved in water and run off. Concentrated material collected in the bottom is washed later in a pan or rocker. In Australia it was much used and worked by horse power in 1860.

The "pan" is pressed from a single piece of Russia sheet iron twelve inches diameter at bottom, fifteen inches at top, with sides inclining outward at an angle of 30°, turned over a wire around the edge to strengthen it. It is used in prospecting, cleaning gold-bearings and collecting amalgam in sluices. Washing requires practiced skill. The pan is filled with dirt and submerged in a tub or pool of water. Gravel is worked with the hands till all cement is disintegrated. Coarse stones are cleaned and thrown out. In washing the residue, the pan is held in a tilted position. By a circular motion and careful use of water, into which the pan is continually dipped, all lighter dirt is worked to the top and over the edge. Pebbles are picked out by hand till only fine gold and black iron sand reman.

The "batea" is a shallow wooden bowl, commonly used in Brazil and Spanish American States for separating, on a limited scale, grains of gold from sand, pyrites and magnetic iron or black sand. A disc of seventeen inches diameter being turned conical 12° will have a depth of one and seven-eighth inches from center to surface; thickness five-eighth inch. Outer edge, perpendicular to axis, requires wood two and a half inches thick for construction; mahogany is used.

Derricks with a mast 100 feet high and boom ninety-two feet, set in cast-iron box placed on sills are used to remove large boulders. The mast is held in position by six guys of one inch galvanized iron wire rope; it has a whip block with three-quarter inch steel rope for hoisting tackle. A twelve-foot diameter hurdy-gurdy wheel is attached, using thirty inches of water under 275 feet head. This derrick will lift stones eleven tons weight. The guys are held by double capstans. Instead of the hurdy-gurdy, at the Alma placer, South Park, a Pelton wheel ten feet in diameter, is used for working the derrick.

Just above Roscoe we found a party of four prospectors sluicing in the decomposed outcrop of a gold bearing quartz vein they had discovered about 100 feet above the river bed. This vein consisted of soft greenish schist, traversed both longitudinally and crossways by small veins of quartz and feldspar. (See Fig. 5.) They had constructed a small wooden sluice, or flume,

FIG. 4.—SLUICE ON A SMALL SCALE, NEAR ROSCOE.

F, VEIN.

about 30 feet long and a foot wide lined at the bottom for the first 10 feet with little wooden riffles or strips of wood an inch apart. The rest of the bottom of the flume lined with tin was full of holes like a colander and the last foot or two was lined with carpet or woollen stuff. They had found a spring about a quarter of a mile up in the mountain and had procured an old used up fireman's hose which they had patched up with rags and canvas to bring the water down to their excavation; at the end of this hose was a tin nozzle about 1 inch diameter. Through this the water was squirted onto the rotten vein and the material washed down into the sluice, the gold as the water and gravel passed over the sluice dropping into the riffles. The greatest amount of gold was usually caught in the first few riffles, what escaped them was caught in the perforated tin bottom and what escaped that in the burlap or carpet. In this way they cleaned up quite a fair amount of gold daily, averaging from 10 to 15 dollars per man. In their clean up they would come across black sand, garnets, and flakes of galena together with the gold. The gold was usually in little flat, somewhat oval flakes. This small scale of mining looked like a diminutive caricature of the huge undertaking going on at Roscoe in the stream below. Doubtless it was from such veins as this that the Roscoe placer derived some of its gold.

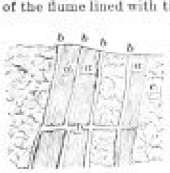


FIG. 5.—GOLD VEIN. a, a, a, DECOMPOSED GREENISH HORNBLENDE SCHIST; b, b, b, b, THIN VEINS OF QUARTZ; c, c, COARSE FELDSPAR AND QUARTZ.

Electricity in Powder Mills.

"The appetite comes while eating" say the French, and that the same principle may be truly applied to the use of the electric motor is emphasized by certain experience which the General Electric Company has recently had with the Aetna Powder Company, of Aetna, Ind.

In November, 1894, this powder company decided to install two small slow speed generators for operating incandescent lamps on the Edison three wire system. As these could not be delivered immediately, two second hand machines were installed temporarily, and before the first two new ones ordered could be delivered, the order was changed to two larger moderate speed generators, with the privilege of changing them for two still larger ones. In June, 1895, the last two were ordered together with two motors, one of one horse power, the other of five horse power. On August 2nd, the Aetna Company ordered another motor of 5 H. P. and on August 14th, still another of the same capacity. The company having enlarged its plant during the summer found its electrical installation insufficient and on October 12th, ordered two 45 Kilowatt moderate speed generators, and two moderate speed motors, one of 20 H. P. the other of 30 H. P. Thus within one year electricity had given the powder company such satisfaction that it now has 66 H. P. in motors and 93 incandescent lamps taking current from the two 45 Kilowatt generators. The one H. P. and the five H. P. motors are used to drive small mixing machines in the manufacture of dynamite. The 30 H. P. motor operates a large machine used for pulverizing nitrate of soda and the 20 H. P. runs a number of machines such as the dry pan and mixing machines. The Powder Company found that the first 5 H. P. motor, which they substituted for a steam engine, readily performed a duty with which the engine found difficulty in doing.

The recent gradual increase in the use of electric power in powder mills is especially noteworthy. During the past year the General Electric Company has equipped several with electric motors and present indications point to the speedy complete elimination of the steam engine from the operation of machinery in and about powder manufacturing establishments.

Written for THE COLLIERY ENGINEER AND METAL MINER.

THE LOOP CREEK, WEST VIRGINIA, COAL FIELD.

Its History, Nature of the Coal, How Mined, Its Analyses, Physical Features.

By Daniel W. Langdon, Ph. D., F. G. S. A.

In 1871, immediately following the labor troubles in Pennsylvania, and upon the completion of the Chesapeake & Ohio Railroad to the Ohio River, Jos. L. Beury, an old anthracite miner, opened the Quinnimont Mine on New River. With the commencement of this operation was marked a new era in steam making, and while these coals are now well-known throughout this country and even in Europe, there may be some hitherto uncollected details of interest to the readers of THE COLLIERY ENGINEER AND METAL MINER.

The coal thus first opened, was in general physical appearance the same as the well-known George's Creek or Cumberland Coal, and not unlike it in chemical composition. It is soft, much broken in mining, so that 80% will pass through a 4″ bar screen and 50% through a 1″ bar screen. This physical character has given rise to much prejudice wherever the coal has been taken into new markets and frequently causes its rejection.

At present this coal is mined in only three districts, two of which, the Pocahontas tapped by the Norfolk and Western Railroad, and the New River tributary to the Chesapeake & Ohio Railroad are already well known, while the Loop Creek, an intermediate district, is of such recent development that it has only within the past few months become a factor.

Upper Loop Creek, known locally as Loop or Dun Loup Creek, is an affluent of New River into which it debouches opposite Thurmond Station some sixteen miles from its sources, having flowed approximately along the strike of the rocks or *N N E*. The drainage is in Fayette and Raleigh Counties, West Virginia. Early in 1893, the Chesapeake & Ohio Railway began the construction of a branch line to develop this region, and in February the following year completed the roadway to Macdonald, the present terminus, ten miles from Thurmond.

The Loop Creek mines are all located in the uppermost or Sewell seam of I. C. White's Quinnimont series, which according to Mr. David White of U. S. Geological Survey (*Bull. Geol. Soc. of America Vol. 6, pp. 305-310.*) is the probable southern extension of the measures under the Pottsville Conglomerate. C. R. Boyd (*Trans. Am. Inst. M. E., Vol. XXIV, p. 255.*) states this series and that at Pocahontas to be identical though in this more northern region the big Pocahontas seam has thinned down below workable size.

A detailed section of the seam shows:

SECTION OF SEWELL SEAM, LOOP CREEK DISTRICT.

1. Sandstone.	
2. Gray slate, very brittle	0-20 ft.
a. Hard coal	12″–33″
b. Soft bright coal	10″–12″
c. Hard coal having columnar structure	24″–39″
d. Soft bright coal	12″–15″
Hard slate floor.	

Wherever the slate (1) becomes less than 12″ thick and the roof is of sandstone, a is very pyritous and unmarketable the vitiating mineral occurring in thin laminae parellel with the plane of stratification. At all times this division of the seam is the most impure of the series, being more or less slatey, though when not too high in sulphur content, it is marketable.

The coal is remarkably pure as the analysis made by Dr. Frœhling of Richmond, Virginia shows:

Hygroscopic moisture	0.52
Fixed carbon	75.80
Volatile matter	21.80
Ash	1.80
Total	100.00
Sulphur	0.37

Coke made from this coal is as yet new to the market and may be said to be in the experimental stage. An average sample of 48 hour coke shows:

Volatile matter	1.10
Fixed carbon	94.78
Ash	4.12
Total	100.00
Sulphur	0.58

This coke was made from 1,000 tons of screenings through a 1½″ "straight away" screen by a prospective contractor and is a reliable sample, not selected, and therefore misleading, as is too frequently the case with published analyses.

The conditions for mining are almost ideal. The average dip of the seam is 4% in the direction of the railway, so that loaded cars come out of the headings by gravity, and the empties are hauled back and distributed by mules. The height of the seam, seldom less than five feet and usually six feet, gives good room for working, permitting the use of good heavy mules. The pillar and stall system of mining is used in connection with a modification of double entry development. The main entries are sixteen feet wide, to permit double tracking, and cross entries on alternate 300 feet centers, ten feet wide, neither requiring timbering as a general practice. The rooms are 24 feet wide and pillars are 29 feet through except next to the main entry where they are 50 feet. The coal is all undercut, there being a soft streak about fifteen inches thick at the bottom while a similar streak near the top permits the use of an ordinary breast auger in preparing for the shots. FFF black powder is used, a keg lasting a careful miner a month. As the mines are all above water level there are no serious problems of ventilation to be solved. In general practice an occasional cross heading is run through the outcrop to the surface and currents resulting from natural draught furnish sufficient air for the men. In some cases a modified Brazil fan is used with satifactory results. The mines are not as yet at all "fiery" and are damp enough to obviate any danger of explosions from accumulations of coal dust.

The miners are paid for a standard car of 72 cubic feet 55 cents in rooms and 70 cents in entries with no allowance for yardage, being required to clean up all slate within fifteen yards of the face and to set all props, the companies laying and maintaining track and hauling props into the rooms on request of the miners.

The track has a guage of 44″, custom differing considerably as to the weight of the rail, though experience seems to show that 40 lb. steel rail in the main entry and 20 lb. rail in the cross headings are necessary to carry the loaded bank cars having a dead weight of nearly 4 tons. In the rooms the track is usually of 3″x4″ oak rail in 14-feet lengths, laid flat on the hard slate floors, the floor being notched to receive the cross-ties spaced about six feet apart.

Each of the six companies maintains a store for the sale of general merchandise in which the prices are somewhat less than those charged by neighboring country merchants. The men are paid off once a month.

The mining population of the district is about 75% whites and 25% negroes the latter being employed mainly as drivers and outside laborers. Of the whites fully 80% are native Americans the remainder being Englishmen with a small admixture of Hungarians.

Men of fair skill and average experience can load six cars a day in rooms and five cars in entries, though instances of seven cars a day per man in entries are not unusual, twenty days being counted a months run because of "car famines" and unwillingness of the miners to do much work after pay day.

The coal finds its market in New England and in the West, taking the place formerly held by anthracite and coming within the "smokeless" provisions of municipal ordinance. It is valued for steam making where continued high pressure is demanded as in electric railways, large manufacturing plants and steam heating. From this district it is shipped almost exclusively without being screened though, through mistaken prejudice, demands are being made for lump while the so-called "slack" is the purest, *i. e.*, freest from ash and sulphur, part of the seam. The following table shows the value compared with anthracite as determined by the Bureau of Steam Engineering, U. S. Navy:

		Rate of Combustion.	New River.	Anthracite.
Rate of Combustion per hour per square foot of grate surface.	Pounds of Crude Coal	Slow,	7.9896	7.7935
		Medium,	13.0534	10.5798
		Maximum.	14.3664	12.9531
	Pounds of Gasifiable Portion of Coal	Slow,	7.4859	6.611
		Medium,	12.2496	8.978
		Maximum.	13.4517	10.992
	Pounds of Water Vaporized per Pound Crude Coal.	Slow,	10.9795	9.9933
		Medium,	10.2023	9.1943
		Maximum.	10.1286	9.9923
	Pounds of Steam Produced per Hour.	Slow,	2636.96	2335.36
		Medium,	3984.14	3171.50
		Maximum.	4369.67	2882.96
	Per cent. of Refuse Ash, Clinker, and Soot.	Slow,	6.367	15.1492
		Medium,	6.367	15.1492
		Maximum.	6.367	15.1492

At the present time there are six companies in active operation and several developing leases. None of the companies owns its own property, all operating under leases at a uniform royalty of ten cents a ton. The following is a list of the companies operating, with their capacities:

	Daily Capacity.	Coke Ovens.	P. O. Adress.
Harvey Coal & Coke Co.	750 tons.	100	Bisset, W. Va.
Collins Colliery Co.	1000 tons.	125	Glenaeau, W. Va.
Star Coal & Coke Co.	250 tons.	....	Glenaeau, W. Va.
Dunn Loup Coal & Coke Co.	600 tons.	....	Dunn Loup, W. Va.
Turkey Knob Coal Co.	600 tons.	....	Macdonald, W. Va.
Macdonald Colliery Co.	500 tons.	....	Macdonald, W. Va.

Worth Having.

Messrs. Frazer & Chalmers of Chicago and London, have recently issued a new catalogue entitled "Gold and Silver Mills." It is a handsomely illustrated volume of 180 pages descriptive of gold and silver milling machinery built in their shops, (they rank as the leading builders in the world), and also contains a few pages of "Useful Information" which ensures that the catalogue will be saved for future reference by every practical gold or silver mining man receiving one. It is sent free, on application, to any owner or official of a gold or silver mine, or to any person contemplating engaging in mining and treating gold or silver ores. A request on a postal card directed to Messrs. Frazer & Chalmers, Chicago, Ill., will secure a copy.

Fatal Accident to a Fire-boss.

Mr. Alex. Howieson, of Delancey, Pa., was instantly killed on the morning of the 10th ult., whilst in discharge of his duties as fire-boss, by a fall of rock in the mines. Mr. Howieson was an exemplary man and stood high in the estimation of his associates and neighbors. He was a member of the Knights of Pythias, and Knights of the Golden Eagle, both of which societies adopted appropriate resolutions on his death.

Written for THE COLLIERY ENGINEER AND METAL MINER.

GOLD AND SILVER MINING.

TIMBERING FOR PRECIOUS METAL MINES IN COLORADO.

The Methods of Working and Conditions Which Influence the Methods of Timbering.

By Francis T. Freeland, B. S., C. S. S., A. S. M. E., A. I. M. E.; Gen'l Mgr. Aspen Contact Mg. Co., Lenado; Durant Mg. Co., Aspen; Isabella Gold Mg. Co., Cripple Creek, Colo., etc., etc.

(CONCLUDED.)

Plate IV, Fig. 8 shows a simple set designed by the writer for the Stevens shaft, Leadville, without side posts. Plate V, Fig. 11 shows the framing of the Penrose shaft, Leadville, through which some 1,800 gallons were pumped a minute. There is a full set of side posts, the dividers are not keyed, but can readily be so designed. The lagging is placed flush by means of 2 by 4 inch strips spiked to the set. In sinking, the new set is swung from the last one by the hangers shown, the posts set up, all drawn snug by the nuts, and then spreading by a chain, or better by having long guide shoes on the cage.

A convenient way of opening a station was used by the writer in the 16th station of the three compartment New Con. shaft of the Durant mine, Aspen. See Plate VIII, Figs. 17, 18. The shaft is 5 by 16 feet and this station was not intended for pumping. On arriving at the floor of a new station, four hitch timbers are wedged under the last set, crosswise of the shaft and clear of the compartments. The shaft is then continued a short distance for a sump as before. The width of the station is such as to cover two hoisting compartments with the jamb chamfered off to afford access to the pumpway.

A three post cap and sill set is placed against the shaft timbers and secured by long bolts and treenails into the dividers. The portions of the wall plate lying between the shaft and the station, opposite the hoisting compartments and breast high in the station, are then sawed out. This method of starting the station is better than having special shaft timbers opposite the station, as they delay the sinking and open too much ground. The station may be continued as far as required and then tapered down to a drift of the usual size.

The station may be covered with ¼ inch steel plates provided with irons to guide the cars on the rails. But I in reaching the rock. However the open caisson, or the pneumatic method to 80 or 100 feet may be used in quicksand without large boulders requiring blasting. The Poetsch freezing system for several hundred feet may be used in quicksand or quicksand with boulders. The Kind-Chaudron method of drilling the full size of the shaft in rock leaving the water in the shaft and following with a metal tubbing is applicable to rock giving a large flow of water. These methods are usually prohibited by their cost and have not been used in Colorado.

The open caisson method of sinking has been used in California drift mining, see Mills; and the shield method in Illinois coal mining, see Rice, with a moderate cost. I believe it possible to use the shield method or perhaps the open caisson method of sinking from a shaft started in the ordinary way in depth on going from hard ground into a quicksand. For instance in such ground as the dolomite sand or contact matter of Leadville where there is a heavy flow of water. But the ground must be drained sooner or later and then the difficulty vanishes. The great danger consists in removing the material running from behind the timbers, when rushes occur destroying the alignment of the shaft timbers and crushing them.

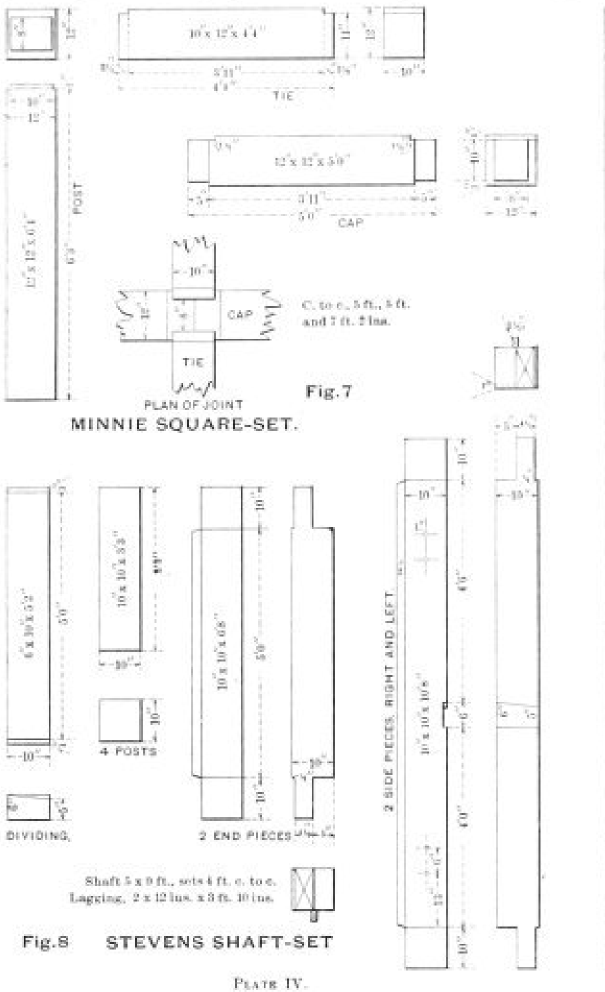


PLATE IV.
Scale [illegible]

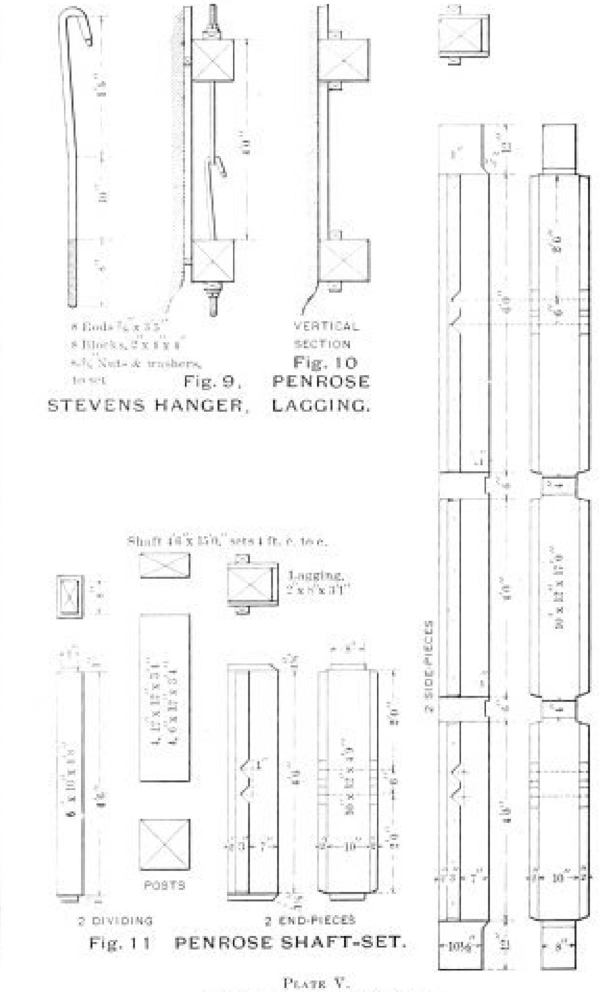


PLATE V.
Scale [illegible], except hook bolt, which is [illegible]

plumbed, blocked and wedged. With this design the dividers can be temporarily left out of the bottom set for convenience in handling the long side pieces and inserted from below. With the former design no hangers are needed on the end pieces. The lagging is set close.

The shaft is plumbed by three or four lines hung in the corners a few inches from the timbers and covering several sets. It is checked from time to time by lines or annealed brass wires with heavy weights steadied in water or oil, extending from the surface or for several levels. The wire may be kept on reels with cranks for winding up. The guides must be accurately set or reset by a template in case the timbers vary much or are crushing.

The Smuggler mine, Aspen, uses for a reserve a water-box running in the guides holding 1,000 gallons, as a relief to the pumps. Four disk valves in the bottom afford ingress to the water. Two of them are covered by a spout and these two are opened wide at the top by a bell-crank lever and rods rubbing on a slide. The spout directs the water clear of the shaft. With such an arrangement water may be hoisted very rapidly and economically.

The shaft may be sunk with a bucket or a bucket hanging under the cage, or with a car on the cage, the cage being run to the bottom on short guides held from prefer the track to be continued to the shaft and a complete siding laid down for standing cars. For a large tonnage it will be convenient to have a tracked bye-pass around the shaft. Then keeping the full cars on one side will permit a quick change. This should be done at the surface at any rate. A fork will then lead to either cage. Spring switches can be arranged to move automatically directing the cars in the proper course. Such a plan is used at the El Paso shaft, Leadville, and also a switch that can be set ahead of the car when running, by the foot to run into the ore-house or to the dump.

In bad ground spiling and perhaps bottom boards may be used with sets. Where little ground can be opened at once, 2 by 12 inch plank may be used cribbed solid, laid flat and breaking joints at the corners. They are inserted one at a time and spiked up from below. The partitions are made of timbers skin to skin, in this case.

A way of starting a shaft I have used with success at the Stevens shaft is to bed a double cross of heavy flatted timber into the original surface of the ground, just outside of the shaft. Then four or more heavy rough posts are erected to a suitable height on this foundation and lagged to carry the collar and gallows frame. The sinking will then proceed without interruption from the surface work.

There is usually little difficulty in this sort of mining

In continually swelling ground sets may be eased by cutting out the lagging or by prying off the strips shown and the removing sufficient ground to relieve the pressure. This work seriously delays the hoisting. On the Comstock a false set has been placed outside the shaft leaving 19 inches clear space. By having chutes down to the next lower level, the easing can proceed without delaying the regular work of the shaft.

A few vertical automatic skip roads have been used in Colorado, but they were not satisfactory and have been abandoned. The handling of timbers and men have a greater relative importance in precious metal mining, especially of the high grade ores, than in other kinds of mining.

INCLINES.

Many shafts in Gilpin, Co., and Cripple Creek are sunk on the vein, and where steep are worked with a bucket on a slide. The California shaft near Nevadaville is 2,300 feet. It is the deepest shaft in the state and is an irregularly inclined bucket shaft. Where the walls are good the shaft may be stulled but if scaly it must be provided with wall-plates or sets and lagging.

The Silver Cord incline, Leadville, 1,400 feet long at 25 degrees pitch was worked by hoisting 6 ordinary mine cars in a train on their own wheels. The main incline, Iron Silver mine, Leadville, 1,100 feet long at 14 degrees hoisted 4 mine cars on 2 gigs running on a 3 feet gauge. These inclines had no separate manway on account of their flatness and were about 6 by 7 feet in the clear.

The McKeon incline, Iron Silver mine, Leadville, sunk by the writer is 750 feet deep at 50 degrees pitch. It was worked with an automatic skip holding about 2 tons of rock running on a 3 feet gauge. The crosscuts and stations came away over the incline and each contained two bins in the acute angle for ore and waste. The skip was loaded from chutes in the incline. At the top there were two bins also provided with a flip-flap door for directing the discharge from the skip. Ordinary cars ran from these bins to the ore-house and dump. The incline was setted with round posts and heavy cap and a flat sill. The hoistway was about 5 by 5 feet and the manway 2½ by 5 feet. The divider was 6″ by 8″ and four braces were used. The manway was partitioned off and fitted with steps. Partitions are necessary in inclines of more than 25 degrees.

The Isabella Incline, Cripple Creek, sunk by the writer, 400 feet at 50 degrees is worked with an automatic skip holding 20 cu. ft. on a 3 feet gauge. The incline and levels are on the vein. The stations are formed by bowing the level out over the incline. The cars to be taken off at each level without interfering with the manway. The Johnson incline above the tunnel has a skip which dumps automatically on reaching the bottom, as the rock is lowered in this case.

There are several important inclines at Creede, the one on the United Mines having three compartments. The incline on the Gregory-Bobtail, Central City, owing to peculiar conditions was on a curve and hoisted 64 cu. ft. cars. These cars where divided in two transversely, being hinged at the top edge and secured at the bottom edge by latches. When dumping they had the appearance of being back-broken. The dirt went between the rails.

The alignment of a gentle incline is similar to a drift, but steep inclines require great care. Four adjustments are necessary and they are best made on the sill. For line a sawcut is made across each sill say 6 inches from one end, before being sent underground. Two hubs are set in the sills on this line by an instrument within 50 feet of the face, and this line is produced by a cord. The new sill is then set by the sawcut and a grade stick, one mud brace being in place. In addition it must be made square with the line and level lengthwise on the corner edge.

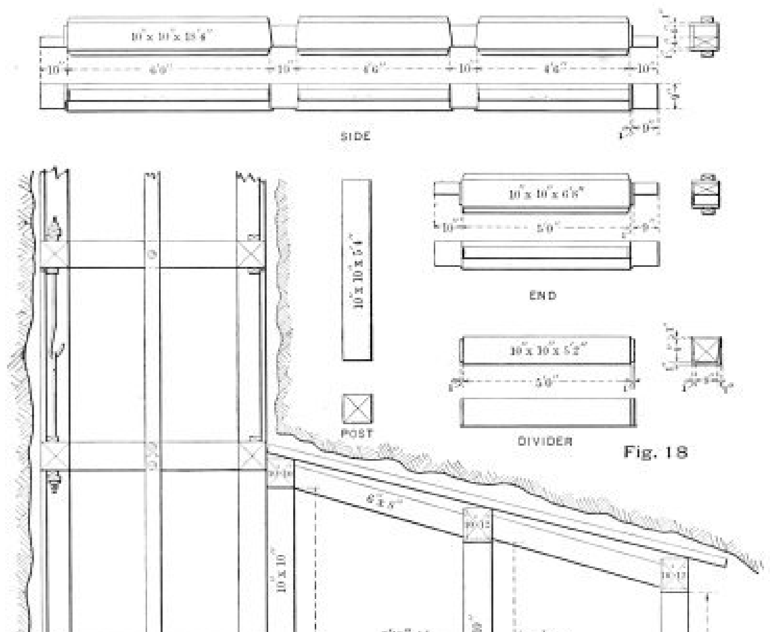


PLATE VIII.
Scale ⅝″ = 1 foot.

mine cars dump directly into the skip through a swinging hopper and at the top the skip dumps into cars. The incline is stulled. See Plate IX, Figs. *a*, *b* and *c*. The hoistway is 5 by 5 feet and the manway 3 by 5 feet with partition, steps and hand-rails. The total excavation is 5 by 11 feet. Cross-sills 4″ by 8″ are spiked against the foot of the stulls and the track is laid on stringers, with guide planks and side planks to prevent derailment. A ¼ inch wire bell rope runs in side pulleys within reach from the skip. A 1¼ inch iron pipe speaking tube is fitted with a T at each level. It is also used to prevent the skip being rung away when in use by rapping on the pipe. The incline is sunk for a new lift without timbering, with a temporary track in the middle and then dressed and timbered from the bottom up. For hoisting water, the skip is furnished with two flap valves, which are replaced by a dead plate when hoisting rock. When hoisting water a hopper on wheels at the collar directs the water into settling tanks. See Freeland, Isabella Incline, *Mg. & Sci. Press*, June 22, 1895.

The Della S. and Alta-Argent inclines from Cowenhoven tunnel, Aspen, designed by D. W. Brunton, Mgr. are about 56 degrees pitch and 6 by 10 feet on edge, the the manway and pumpway being above the hoistway which is 5 by 6 feet. The tunnel cars described above are hoisted on an inclined cage. This plan enables the

STOPES.

The timbering of the stopes of precious metal mines as ordinarily practiced depends principally upon the size, shape and inclination of the ore-bodies, and the firmness of the country rock, for these conditions determine the method of mining. For the present purpose ore-bodies may be grouped as to shape into three classes; 1st. A flat or gently inclined continuous or interrupted sheet of moderate thickness; 2nd. The same vertical or pitching strongly; and 3rd. Masses, pipes, and great local thickening in a sheet. Sometimes all these varieties may be seen in one mine.

FIRST.—FLAT THIN DEPOSITS.

Ore-bodies of this sort are often seen in the so-called contact mines of Leadville, Red Cliff and Rico and in deposits following lines of stratification. They are worked to the rise if possible.

Where the ore is continuous it will be worked by a system resembling long-wall in coal mining, either advancing or retreating. Where the ore is interrupted the method will resemble pillar and room, the pillars being irregularly placed and consisting of poor ore or waste rock left in place. Where the roof is firm no timbering at all may be required, or at most an occasional prop under a threatening rock. If timber is used some of the posts may be drawn if the stope is to be abandoned.

With a tender roof, posts and head boards will be used for a height up to about 8 feet. With a heavy roof or for a local thickening up to about 16 feet cribs will be used from 7 to 16 feet square. Filling with waste will steady them. They will have runways between and may be lagged from crib to crib. When filled they generally fail by bursting near the bottom.

Where the roof is bad, but the deposit nearly plane and of a fairly uniform thickness, the ore may be won by a succession of parallel contiguous drifts, timbered with drift sets, consisting of posts and lagged caps, each post carrying the ends of two caps, and steadied by collar braces to the last set. This plan admits of considerable irregularity. The waste coming from underground ore-sorting in the stope is filled back, if there be room for it. It is advisable to fill exhausted stopes in bad ground to prevent extensive movement in the country rock which may bring weight upon or wreck neighboring stopes, main levels or constructions on the surface. In bad ground the timbers are lost.

SECOND.—STEEP THIN DEPOSITS.

Ore-bodies of this shape are commonly found in fissure veins, dykes or on the edge of dykes, as in Gilpin or Clear Creek counties and in Rico and Cripple Creek, and sometimes in steep contacts and deposits following pitching stratification planes, as in Aspen. They may be worked underhand or overhand.

In underhand stoping a winze through the stope and connecting with the next lower level is advisable, as it does away with the windlassing and assists in ventilating and draining the workings. Underhand stoping may be resorted to before the level below is driven in case of necessity. It is not, however, economical nor systematic mining and is one method of "gouging the eyes out of the mine." It makes easier drilling and may be useful in a country like Mexico, where the natives rarely become expert at drilling "uppers." Where the ore is narrow and rich it may be adopted in small mines, as the ore can then be readily kept from the waste filling of the stope. The floor may be swept with steel wire brushes.

If the walls be good and the waste removed, or if the vein is of a width requiring the breaking of neither of the walls, the stope may be worked without timber. But if the waste be stored in the stope as made, more timber is required than in the other method. The ground is broken from the top of the winze each way in benches of about 6 feet, like two sets of stairs.

Overhand stoping is the more generally used, as it is the faster and cheaper. The ore, waste and water fall away from the breast. In a narrow vein giving considerable waste, the stope may be filled to within 5 or 6 feet of the top, as made, giving a convenient footing for the miners, the excess, if any, being sent out. To collect the ore, canvas is laid on the waste and protected by rough plank. In narrow veins stulled millholes about 3 feet wide are run up at intervals of about 25 feet to afford access and for throwing down ore and the excess of waste. The end breast or raise stopes are provided with ladders. The main line of stulls is placed 11 feet above the track. Under each millhole is a plat with loose cross boards over the car track, laid upon three horizontal spreaders 6 feet above the track, to keep the ore off the main road and to afford a loading chute. In a vein wider than 4 feet the millholes will be cribbed. They may have two compartments, one for a ladder way. About 3 feet square is sufficient, and they may then be climbed without a ladder by straddling the hole.

When the vein makes but little waste, the opening must be stulled to afford a platform for the miners. Where the walls are good many of the timbers may be recovered when the stope is abandoned. It is then filled with waste from the level above. Where the roof is bad the stulls will carry wall plates and lagging on one or both walls, with braces as required.

When the vein is moderately wide with good walls and makes but little waste, the broken ore may lie in the stope, only enough being drawn off to keep the top about 6 feet from the breast. This plan requires no mill holes, for when the stope is finished the ore remaining is all drawn off. The flat chutes and the main line of stulls is the only timbering required.

Where the vein is of moderate width and is soft or has a soft gouge in it, that will be taken out first in order to have some open space to shoot to, using a gouger if the soft streak is narrow. Where the vein is harder than the walls and especially if it be "frozen" on one or both walls, the softer wall will be shot first and then the ore stripped from the remaining wall by pop shots. Where they are of nearly equal hardness it will be best to shoot the ore first if it be big enough to get a proper shot into and then take out enough of the footwall for convenience of working. But if the vein is very narrow and rich and adheres strongly to the footwall, the hanging wall may be broken first and then the ore stripped.

THIRD.—MASSES.

Ore bodies of large and irregular dimensions occur frequently in a limestone formation, such as Leadville and Aspen, and in enlargements in fissure veins and contacts. Where they reach the surface open-cut work is resorted to without timbering, as deep as the walls will stand, or until the cost of removing the overburden is prohibitory in a flat deposit. It is possible that in exceptional cases the caving or filling systems used with success in the Lake Superior iron mines might be employed.

Having regard to the peculiar conditions here the square set system is the only one of general application. Precious metal ore masses are extremely irregular and the prices obtained for the ores vary from year to year. It is often necessary after stopping work at a certain place to resume it. New discoveries in the neighborhood may alter the probabilities of ore in any given

-direction. The ground may be reworked to some extent with square sets, if not caved, while with other methods the ground must be abandoned as mined.

SQUARE SETS.

The origin of the system is a simple and natural extension and refinement of the practice of running contiguous parallel drifts in the ore and in two or more stories when the thickness of the ore required it. The first step in the way of improvement was the obvious one of making the two butting caps rest upon the same post, and to make the collar braces of equal strength to that of the other members. The regular use of such sets and their framing on the surface to standard dimensions appears to have been first introduced on the Comstock lode by Phillip Diedesheimer, Superintendent of the Ophir mine in 1860.

The sets may be so framed that the posts, caps, or ties run through and touch, the continuous longitudinal grain of the timber being laid in the direction of the greatest pressure. In very heavy ground this is important, but in most cases it is sufficient and more convenient to let the caps run through. The pieces touching on end grain are cut a trifle scant to equalize the pressure. The caps are set the narrow way of the ore body. The sill floor set is usually one foot higher than the regular set. Where the posts run through, a special lead or cap sill must be used in starting a run of sets, but where the caps run through it is not always necessary.

Where the sill floor is laid upon a large body of ore, which is to be mined from the next lower level, sills covering several sets should be used. No matter what care be taken in starting the next lower nest of sets, it is not likely that they will exactly join. Long sills render less difficult and dangerous the work of taking up the weight as the two nests connect. In coming up from below the posts of the top row of the lower nest are cut so as to leave a space of about 2 feet between the two nests. Long heavy stringers are laid on the lower nest to break joints and the intersections of the upper nest caught up one at a time with blocks and wedges.

Where the walls are bad, plates should be used covering several sets and joined by special pieces to the regular sets. With a good roof it is sufficient to securely block the sets at each intersection in the same way as at the sides of the stope.

Where oblique pressure is expected or develops, plain diagonals with a double chamfer at each end must be fitted and wedged in the sets already in position, which may be inclined to cant. Two diagonals placed like an A will permit a single post to be removed in order to gently divert a car track running through the stope. Where the posts show a tendency to cut into the caps, they may be assisted by two or four helpers or false posts ½ the size of the main post and placed around it.

The sets usually fail by crushing and racking so that the caps slip off the posts. To prevent this, solid cribs of timber in a row of two or more sets wide are placed in the sets crosswise of the ore body from wall to wall.

Another crib may be built further on and the space filled with waste. Cribs are also important under the main workings.

The whole floor of a large ore body must not be opened at once as too much weight is brought on the timbers. It is safer to take out vertical slices crosswise of the ore body from level to level and three or four sets thick in succession. In very large bodies pillars may be left which can be robbed as the mine is gradually abandoned. But if sufficient weight comes upon the pillars to crush and splinter them, serious trouble will be encountered on taking them out afterward.

The system is designed for working overhand although with care a small pothole may be worked underhand and timbered. With a rolling bottom, short posts on foot pieces may be used sparingly instead of shooting enough waste to hold a complete set. A run of cells may be readily lined for a chute. In starting a nest it is not well to work in opposite directions at the same time as the shots may shift the timbers.

After a nest of sets has crushed and caved, it may be necessary to open the ground again. There will usually be a heap of loose shifting rock and timber in the bottom of the old stope and a large open space above having a shaky roof. About the only thing to be done is to fill and level off a floor and cover it with a mattress or solid filled crib of timber to serve as a foundation for sets or open cribs. In other cases the hole may be filled and mined around by spiling and cribbing from raises in the neighboring solid rock, or similar special methods suggested by the particular circumstances and the relative location of the spot it is desired to reach.

The timbers may be snubbed down from the level above through a winze or taken up with a windlass or small hoist. On abandoning a stope most of the flooring is taken up leaving enough to enable an inspection to be made. If no further prospecting is intended from the stope, it may be filled with waste from above to prevent extensive movement of the ground. In exceptional cases the sets may be robbed.

Of available timber red spruce is more durable than yellow pine, and that, than white spruce. The sets are framed by machinery. Englebach of Leadville makes a four saw machine which uses square timber. The Hendey framer an eight saw machine is made by the Denver Engineering Works. Round posts can be cut on the latter giving additional support to the caps and ties.

In starting the system in a mine some thought should be given to the style and dimensions, as it is inconvenient to change the patterns when once adopted. The height should be about 6 feet in the clear allowing for the flooring of 3 or 4 inch plank, and the width from 4 to 5 feet. The usual sizes of timber are 10 and 12 inch according to the probable size of the stope and the character of the walls. One small mine uses 8-inch sets. Larger sizes will be used in special cases. The 10-inch timber is to be preferred for economy and ease of handling if the ground will permit.

DETAILS OF SQUARE SETS.

Plate II., Fig. 4, shows the square set used by the Moyer and other mines of the Iron Silver Company of Leadville, which has shipped 125,000 tons in a year. The tenons on the posts touch and the ties are plain. The lower tenon is short to prevent much accumulation of dirt in the built up mortice. The flooring is 6″ x 8″ x 5′ 0″. The diagonal braces are 10″ x 10″. Centres to centres are 5, 6 and 7 ft.

Plate III, Fig. a, shows the set used by the Aspen, Durant, Regent and Smuggler mines at Aspen, shipping about 75,000 tons a year. The posts touch and may be round or square. The cap sill is used on the sill floor for a single row of sets, and the lead sill for further extensions sidewise.

Plate VI, Fig. 8 shows the set largely used at the Mollie Gibson mine at Aspen. The caps touch, the caps and posts are entirely symmetrical and the tie also, in but two directions however.

The set used by the Little Johnny mine of the Ibex company, Leadville, shipping about 75,000 tons a year is of 10 inch timber, except the tie. It is 4′ 4″ cap way by 4′ 10″ by 6′ 10″ centers, and 3′ 6″, 4 feet and 6 feet in the clear. The caps touch and the framing resembles that of the Mollie shown already. The posts are 6′ 4″ over all with 6 by 6 by 2 inch tenons. The ties are plain 6 by 10 inch timber and 4′ 4″ long. The caps are 4′ 4″ over all with 6 by 6 by 3 inch tenons. These sets are also used for drifts.

The set used at the El Paso mine of the Union Leasing company at Leadville, shipping about 25,000 tons a year is also of 10 inch timber except the tie. It is 5′ 4″ by 5′ 4″ by 7′ 4″ centers and 4′ 6″ by 4′ 6″ by 6′ 6″ in the clear. The caps touch and the framing is like the Johnny. The posts are 6′ 8″ over all with 8 by 8 by 1 inch tenons. The caps are 5′ 4″ over all with 8 by 8 by 4 inch tenons. The ties are plain of 8 by 10 inch timber and 4′ 8″ long. If full sized ties are deemed necessary they are to be notched at the corners like those of the Mollie.

PLATE IX.

These last three styles possess many advantages and can be recommended. They may be readily designed for 12 inch timber or larger and for round posts. It is not necessary that they should be cut from sawed timber without waste as large amounts of blocking and wedges are used. The wedges are 3 by 4 by 14 inches.

LADDERS AND STEPS.

Vertical ladders may be permitted in a pumpway for occasional use and for a limited height. In general they should be set at least 10 degrees from the perpendicular. 12 inches wide in the clear is enough for the rung but the manway must be at least 24 inches wide, better 30 inches to allow for the play of the shoulders in climbing. The platform holes should be 24 inches in the clear from the face of the ladder and the road itself about 30 inches. Ladders will be used with inclinations over 60 degrees. The distance of the rungs or slats is 12 inches for inclined ladders and short stretches. Steep ladders have spaces of 11 inches, and for vertical ladders or long stretches 10 inches for the minimum. Plate VI, Fig. c shows a cheap and serviceable ladder for general use.

It is more convenient to use steps and hand rails in inclines for pitches less than 60 degrees. From 60 to 45 degrees the tread should be six inches and the slope distance between 11 and 12 inches. The width of the step in the clear should be 13 to 14 inches. 6 feet vertical headroom should be allowed.

Plate VI, Fig. d shows a flight of loose steps designed for the Aspen square set. It consists of 9 steps, just reaching from floor to floor by resting on the caps or ties, either with or without the flooring.

With pitches from 45 to 20 degrees the ancient carpenter's rule applies, twice the rise plus the tread equals 24 all in inches. Below 20 degrees nothing is required although sometimes a plank walk with cleats at equivalent intervals is used.

Uniformity in the ladders and steps both in interval and arrangement in the shafts and inclines will prevent accidents and increase the speed and ease of travel.

LITERATURE.

J. D. Hague. Mining Industry. U. S. Geological Exploration of the 40th Parallel Washington, 1870. Vol. III, pp. 103-108, 112-114, 511.

J. S. Curtis. Silver-Lead Deposits of Eureka, Nevada. U. S. G. S. Washington, 1884. Monograph VII, pp. 154-157.

W. H. Storms. Methods of Mine Timbering. California State Mining Bureau. Sacramento, 1894.

L. D. Ricketts. The Ores of Leadville, etc. Princeton, 1883. Pp. 49-57.

J. E. Mills. A new method of shaft sinking through water-bearing loose materials. Trans. A. I. M. E., N. Y., 1885. Vol. XIII, pp. 216-231.

G. S. Rice. The sinking of the Ladd shafts. School of Mines Quarterly, N. Y. Vol. XVI, No. 3. April, 1895, pp. 234-250.

C. A. Sickel. Die Grubenzimmerung. Freiberg, 1872.

The general treatises and pocket-books on mining rarely give much space to the details of the dimensions and use of the various styles of timbering. The several excellent text-books on tunnelling give the special methods demanded by the larger work.

Many valuable papers bearing on this subject may be found in the Transactions of the American Institute of Mining Engineers and in the publications of other engineering societies.

For the periodical literature see Francis E. Galloupe. An Index to Engineering Periodicals. Vols. I, II. Boston, 1888 and 1892. Descriptive Index of Current Engineering Literature, Chicago, 1892. The Technical Index, Engineering Magazine, New York.

TWO SOUTHERN MINE DISASTERS.

One at Cumnock, N. C., Results in the Death of Thirty-five men, and the Other at Dayton, Tenn., Kills Thirty Men.

An explosion, supposedly of fire-damp, at the Old Egypt Mine at Cumnock, N. C., on the 19th ult. resulted in the death of thirty-five men. The mine is an old one, having been first opened about fifty years ago. It was only worked a short time, and was then abandoned, till, during the civil war it was worked by the Confederate Government to secure coal for blockade runners.

A few months ago it was bought by the present owners, who have spent a great deal of money in re-opening and improving the property. The opening out of the mine proved that the coal improved in quality as the workings extended further into the bed.

The mine was inspected by the fire-boss at six o'clock, was reported free of gas, and sixty-six men went down the pit. At eight o'clock the mine was again reported free of gas. A few minutes after eight o'clock, an explosion occured that killed all of the men in one of the two divisions of the mine, and two who were in the other division. Those not killed, thirty-one in number groped their way to the shaft in the dark, and were speedily hoisted to the surface. The shaft was not injured.

At first it was supposed that 250 lbs. of dynamite, stored in a closet in the mine, had exploded, but examination proved that such was not the case, as the dynamite was found all right.

As usual there are numerous rumors as to the cause of the accidents. One rumor states that a man was slightly burned by an explosion of gas the night before, and that there was gas found on the morning of the accident, and that each man was instructed to "brush" the gas out of his working place. If there was enough standing gas in the working places to warrant the men being instructed to "brush" it out, somebody is morally responsible for the death of the victims. The removal of gas by "brushing" is wisely prohibited by both mine laws of Pennsylvania, and it should be prohibited in every state. If there actually was no gas found by the fire-boss, when he made his examination, the disaster was either caused by a sudden outburst of gas, or by an explosion of coal dust. What the cause actually was will be hard to determine as all the men in the affected portion of the mine were killed.

The disaster at Dayton, Tenn., occured in the Nelson Mine, operated by the Dayton Coal & Iron Co., on the morning of the 20th ult. It resulted in the death of thirty men. The telegraphic reports of this accident are so conflicting and contain so many inconsistent statements, evidently by men devoid of any mining knowledge, that we refrain at this writing, from trying to sift out a probable cause for the accident.

Acknowledgement.

We have received from the Jos. Dixon Crucible Co. of Jersey City, a box of assorted Dixon American Pencils, with the compliments of the season. If there is any class of men who appreciate good smooth pencils, it is editors, and on account of the uniform good quality of Dixon pencils, we use no other kind for editorial work. Our force of draughtsmen also use Dixon drawing pencils in preference to any other make. In fact, among the ninety people in the offices of The Colliery Engineer Co., no other brand of lead pencils is used for any purpose.

The Westinghouse Electric Co.

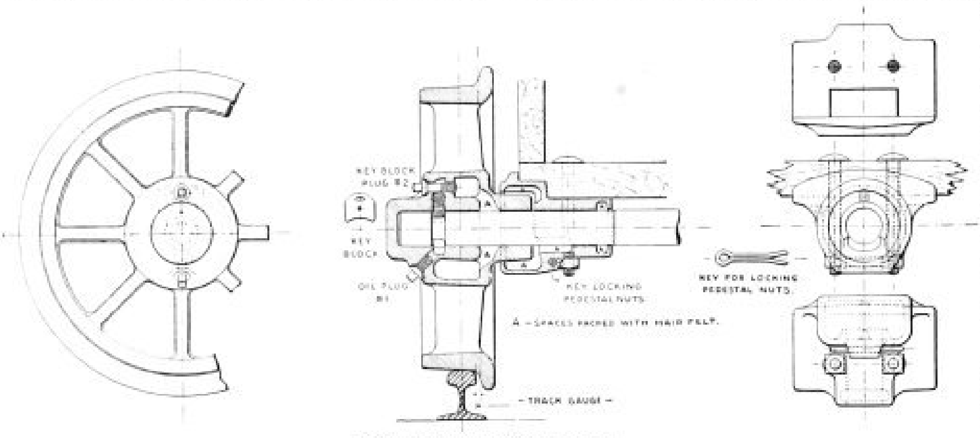
The Westinghouse Electric and Manufacturing Co. of Pittsburgh, Pa., the sole owners of the valuable Tesla patents, have decided to make a vigorous fight for the mining trade in electrical machinery. To speak of Westinghouse electrical appliances as first class, is superfluous. Their success is known to all mine managers. The advertisement that appears, for the first time, in this issue, is evidence that the company is prepared to furnish first class mining machinery that will compete in every way with any now on the market.

THE FAUGHT PATENT WHEEL FOR MINE CARS.

A New Self-Oiling Wheel that is Worthy the Attention of Mine Managers.

During a recent visit to the extensive and well known car wheel works of Messrs. A. Whitney & Sons of Phila., we were shown the drawings of an improved self-oiling mine car wheel, which seemed to contain many valuable features. We therefore made arrangements with Messrs. Whitney & Sons to illustrate and describe the wheel. For many years this firm has made a special study of the requirements of mine railways. An experience of nearly 50 years in the manufacture of chilled car wheels for all varieties of service peculiarly fits them for such study. It is their belief that true economy in this service demands the best material and workmanship and also that to insure the highest efficiency and durability, patterns carefully designed on scientific principles must be used.

Under this belief they have introduced a self-oiling wheel which has many points of the highest excellence. The wheel, in combination with its pedestal and other fixtures is the invention of Mr. Luther R. Faught, their mechanical engineer, and its construction, in its latest improved form is illustrated herewith.



FAUGHT PATENT MINE CAR WHEEL.

The wheels are cast with the outer hub solidly enclosing the end of the axle. The inner hub enters a dust collar in the pedestal casting lined with a broad band of hair felt, which serves to exclude all dust and grit from the wearing parts, and prevents leakage of oil. With their standard wheel a round axle is used which can turn in the pedestal when on curves. This diminishes friction and equalizes the wear on the axle. At the inner end of the pedestal there is a smaller band of felt acting as a further protection against dust and leakage. Sufficient oil flows along the axle into the pedestal to lubricate the axle bearing.

The wheel is held on the axle by the "key block" socketed in the wheel and entering a groove turned near the end of the axle. The key block is retained in position by the horizontal "key block plug." By removing this plug and revolving the wheel so that the hole is down, the block drops away from the groove allowing the wheel to be pulled off. The wheel is replaced by reversing this operation, first placing the key block in its socket in the wheel, by the aid of a pointed stick inserted in the hole in the key block.

Oil is introduced into the annular chamber in the hub through the oil hole entering the wheel at an angle. This hole is closed by the "oil plug." Both plugs are provided with leather washers so that when screwed into place, the holes are closed *air tight*. The leakage of oil is thus to a great extent prevented by *atmospheric pressure* and any slight flow being *outward* only, the chances for dust working into the wearing parts are greatly diminished.

Should the oil plug, however, be accidently left out, the main body of oil will be retained in the cavity for a long time, as no oil can run out of the oil hole without first rising to a level with the lower side of the axle.

To meet an objection which is sometimes raised to the loss of time in oiling, from the necessity of removing and replacing the oil plug, a new device has been recently made experimentally. This consists of a "self closing oil plug" so constructed that on inserting the spout of an oil can or syringe into the oil hole, a valve controlled by a spring is pushed inward allowing the oil to enter, and on withdrawing the spout the valve again closes the opening.

Thorough lubrication of the entire length of bearing is ensured by two openings connecting the rear end of the oil cavity with the bore of wheel. It has sometimes been found that when wheels run at a high rate of speed for a considerable time, the bearings have a tendency to run dry because the oil, by centrifugal force, is thrown toward the outer walls of the oil cavity. To obviate any trouble of this kind, strips of felt packing are inserted in the two above mentioned openings, their object being to act as wicks to draw the oil into contact with the bearing surfaces.

The length of bearing of the wheel on its axle is very much more than usual with loose wheels. The position of the hub relative to the tread is such as to bring its centre directly over the rail. This obviates the tendency of a short hub to "cant" on the axle, with the consequent cutting of both wheel and axle. These two features in connection with close and accurate fitting greatly prolong the life of both wheels and axles. The long bearing, however, is not obtained by lengthening the axle or diminishing the width of car bottom, but as the usual lynch pin is dispensed with, the additional total length of axle it requires is all available for bearing surface. As an actual fact there is a saving in the total length of axle, a pair of these wheels measuring less from out to out than those fitted with lynch pins in the ordinary manner.

The pedestal castings are so constructed as to do away with the collar usually welded on mine car axles. A split key on the lower side locks the nuts of the pedestal bolts so that they cannot become loose from jarring. In cases where the regular form of pedestal is not adapted to the construction of car bottom, special pedestals can be made to suit all requirements.

Though the use of round axles is recommended, where it is desired to have the support of the car bottom which a square axle affords, this form can be used.

In the manufacture of these wheels, the very best car wheel irons are used under chemical and physical tests, in the firm's own laboratory and shops. The material is the same as used in their heavy wheels for freight and passenger cars which must stand the severe inspection and tests required by the principal railroad companies. All wheels are thoroughly annealed in furnaces especially constructed for the purpose. Carefully proportioned patterns are used, adapted for each diameter of axle and for the service intended. Fitting is done by standard gauges, all parts being interchangeable and both material and workmanship are guaranteed against defects.

Not only are the treads and flanges well chilled to resist hard wear on the rails, but the spokes and hubs are very strong and tough to stand the most severe shocks in rough service. These two most important qualities are supplemented and made fully effective by the efficiency of the oiling arrangement and the protection of wearing parts. The result is a wheel perfect in all its parts and which will give the longest possible service, no one part wearing out before the rest.

From the above description it appears that Messrs. A. Whitney & Sons are using every known means to produce the most durable, efficient and economical mine car wheels possible. Nearly 30,000 of the closed hub wheels have been put in use under most severe conditions in all parts of the country and they invariably maintain the points of excellence claimed by the makers. One large user in the far West, after holding for a year a supply of *extra* wheels ordered "to replace any that might be broken or worn out," ordered sufficient new axles to utilize these wheels, stating that "as none had broken or worn out and showed no sign of doing so, they had concluded not to hold the wheels any longer for repairs." This appears to be the experience of most users as but few *extra* wheels are ordered.

Another writes that after most severe service for a year he "examined the axles and the hub, and found no wearing of the surfaces in either place and the tread was as good, not worn in the least, as the day they were first run out. Had I not seen the wheels I should not have thought it possible in our mines that anything could stand so long." Still another points with pride to the sleek condition of his mules who, he says, are growing fat as a result of the easy running of the Faught wheels.

Some of the various types of Whitney wheels have been, and are in use in practically all the mining fields on this continent, and they are everywhere held as the standard in quality. Hundreds of letters from mine managers attest their appreciation of Whitney wheels. The following is a recent one, expressing an opinion of the Faught Patent Closed Wheels. The wheels referred to by Mr. Phillips are not exactly the same as the wheel we illustrate. The latter is a further improvement on the kind Mr. Phillips purchased:

CENTRAL JELLICO COAL COMPANY.

Pleasant View, Whitley Co., Ky., Dec. 9, 1895.

MESSRS. A. WHITNEY & SONS,
Philadelphia Pa.

DEAR SIRS:—In reply to yours of recent date, we bought of you, something over two years ago, (June 1893) enough wheels and axles of the Faught Patent Closed Hub Self Oiling for forty mine cars. They have been in constant service ever since and are apparently just as good as when first bought. We have several long and heavy grades which call for a great deal of spragging, this, of course, makes it very hard on the face or tread of wheels, but I have found these wheels in no shape, whatever, worn. Also the round axles being able to turn when necessary saves them from wearing and bending, always lubricating themselves and hub of wheels, so there seems to be no cutting on either axles or hubs. We find it takes less than half the amount of lubricating oils to keep them in good running order, which is quite an item to us. Also we have no trouble with broken lynch pins in your wheels which causes us much trouble with most other makes. We are using several other makes of wheels and axles but find the A. Whitney & Sons much superior to all others which we have tried.

We will be ordering several sets of your wheels and axles this coming Spring and Summer to replace other makes which have worn out and been of little service to us.

Yours respectfully,
THE CENTRAL JELLICO COAL CO.,
Per John Phillips, Supt.

DRY STEAM.

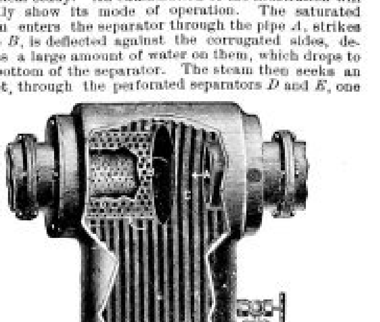
Its Necessity and How to Ensure It.

The length of steam pipe lines at mines is generally such as to materially reduce the efficiency of the power, and often to cause breakages due to the use of saturated steam in engines and pumps. The covering of steam pipe lines with a good steam pipe covering naturally reduces condensation greatly, and enhances the value and safety of the power, but such covering does not *entirely* remedy the evils of condensation. No reputable maker of pipe covering will make such a claim.

There is but one way to entirely remedy the evil, and that is to prevent condensation as much as possible by the use of a good covering and then complete the work by using a first class separator. When the line is a short one, and steam is plentiful the separator alone will do the work, but best results are obtained in most instances by the use of both covering and separators.

Reputable makers of steam separators will endorse this statement, and the practical experience of many large steam users has demonstrated the fact.

There are many types of separators on the market of more or less value, and it is important that our readers should be informed as to the existance of one that is extremely simple in construction, and very efficient in operation. It is known as Robertson's Steam Separator, and it combines every necessary feature in such a device without those objections so noticeable in most others. This separator is the outgrowth of years of experiments and practical study. An examination of the illustration will readily show its mode of operation. The saturated steam enters the separator through the pipe *A*, strikes plate *B*, is deflected against the corrugated sides, deposits a large amount of water on them, which drops to the bottom of the separator. The steam then seeks an outlet, through the perforated separators *D* and *E*, one within the other, is again broken up, deposits what little moisture remains in it, and passes on to the cylinder perfectly dry, and does the most efficient work in a perfectly safe manner. The water taken from the steam is drawn off through the valve at the bottom, the necessity for this operation being made apparent by the water column. This separator is manufactured only by the Hine and Robertson Co., 48 Cortlandt St., New York. It is not an expensive contrivance, and is worthy the attention of all mine managers using steam power.



ROBERTSON'S STEAM SEPARATOR.

H. E. Collins & Co., Pittsburgh, Pa., sole sales agents for the Cahall Vertical Water Tube Boiler, manufactured by the Aultman & Taylor Machinery Co., Mansfield, Ohio, report the following recent sales of Cahall boilers: Douglas Furnaces, Sharpsville, Pa., second order, 250 H. P.; Mahoning Valley Iron Co., Youngstown, Ohio, third order, 300 H. P.; Michigan Alkali Co., Wyandotte, Mich., third order, 250 H. P.; Shoenberger Steel Co., Pittsburgh, seventh order, 500 H. P.; Traders Paper Co., Lockport, N. Y., 500 H. P.; McKinnon, Dash & Hardware Co., Troy, Ohio, 100 H. P. The boilers for the Douglas Furnaces and the Shoenberger Steel Co., are for blast furnace gas,—those for the Mahoning Valley Iron Co., are for the utilization of waste heats from heating furnaces, while the others above mentioned are of the standard direct fired type.

THE CAUSE OF MINE EXPLOSIONS.

EFFECTS PRODUCED BY THE SUDDEN COMPRESSION OF THE AIR IN MINES.

Description of Unusual Explosions in Coal Mines. With Conclusions Reached After Thorough Examinations and Study of the Conditions Existing Subsequent to the Explosions.

(James Ashworth, M. E., in *The Colliery Guardian.*)

On the 18th of July of the present year a most unusual accident occurred at the South Mine of the Broken Hill, South Australia, by which at least nine men lost their lives. Mr. J. B. Giuyas, the general manager of the mine, thus describes the occurrence:—

We had indications yesterday at about noon, that the ground in the north sulphide stopes at the No. 4 level was affected. I gave instructions to the underground foreman to warn the men of the fact. This was done at the time of the accident, and they were fully 200 ft. from where the creep took place. No doubt they were loitering and talking, feeling perfectly secure,as I would have done had I been there—in fact I would not have been afraid to have stood within 20 ft. of the break. The only explanation I can offer as to the cause of the accident is that our ore is full of gas, which is held in the crevices, and I think that when the break came it forced the air through the tunnel like a man putting a ram-rod into a pop-gun. Had the men desired they could easily have reached the mouth of the shaft, but they very reasonably felt safe where they were. As it transpired, a safer place for the men would have been the No. 1 cross-cut, where there is a deep winze, but they never thought of that. When the creep took place it forced the air, which being charged so heavily with gas was like a solid body, along the only outlet—namely, the level—and the men who were gathered there were knocked over with terrible force and killed. It is marvellous how one man—John Treloar—escaped, as he was one of the nearest to the creep. Possibly he got behind a post, and thus escaped the current of air. I have never in my experience of mining heard of such a disaster. Of course in coal mines firedamp sometimes causes the death of large numbers of men, and I have known a dam of water to break through and drown men engaged in the workings, but the death of men in a silver mine through concussion of air is something phenomenal. The South Mine has been singularly free from fatal accidents, only two men having previously met their death in it. Richard Mortimer, who was in the hospital, says that he was standing near the plat in the mine when he was suddenly lifted off his feet and instantly lost consciousness. A youth who was engaged near the mouth of the shaft at the No. 4 level pumping air up to the men working in the stopes, had a narrow escape. When the creep took place the air came along the cross-cut to the shaft with such force that it took him off his feet, and he fell with his feet dangling down the shaft. At the inquest the evidence showed that the men received ample warning, but remained in the level chatting and smoking, and one man who escaped injury deposed that they were all about 300 ft. from the stope when they heard a sound like a peal of thunder, followed by a rushing noise. Being an old coal miner, he fell flat on his face and thus escaped death.

LLANERCH COLLIERY EXPLOSION.

No information is afforded as to what kind of gas is referred to by Mr. Giuyas, but it cannot have been explosive nor yet poisonous, as no mention is made of any gas by those who escaped, and the effects may therefore be considered as entirely mechanical and resulting from the creep and fall.

If, then, such excessive violence can be exerted by a sudden compression of the ventilating current and without the assistance of explosives or inflammable gas, it becomes quite clear that if the ventilating current of any mine is suddenly and violently compressed, we shall on reference to the published details and plans of explosions in coal mines be able to identify some of the indications which are due to compression, and also possibly revise some of our notions as to how these accidents become so widespread and so fatal to life.

One of the first conclusions that we are forced to perceive and to adopt is that no fall of roof can take place until after the compression stage, excepting only where gas is exploded by the flame of the initiatory explosion.

The falls of roof, excepting only those caused by direct violence, must then be due to the sudden expansion of the gas or air which has been compressed into the crevices and vacancies above the roadways and which will endeavor to find an exit in an equally sudden manner as soon as the condensation and vacuum stage commences.

In the Llanerch accident the compressive effect was very noticeable in all the narrow headings on the lower side and ends of the levels,where nearly all the men lost their lives in their working places,whereas those on the higher side having the elasticity of a larger area of reserve air to protect them, were, with very few exceptions, enabled to run some considerable distance outbye before succumbing to the after-damp. Compression in this case was entirely due to the accidental ignition of a small pocket of fire-damp which had collected in a hole above some new timbering in No. 4 level. The extent and completeness of the accident is very astonishing when it is observed that all the workmen used candles only, and therefore explosive conditions could not have been present in the ventilating air-current. And supposing that a quantity of gas had been continuously escaping from No. 4 level, this would have been entirely nullified by the large volume of carbonic acid gas created by the candles and the breathing of men and animals, and therefore there could not have been explosive conditions present in the ventilating air-current.

In the Camerton and Timsbury accidents the conditions were so very much alike in both cases, as far as regards ventilation, humidity of the air, dust, the explosive used and its mode of application, that the more recent explosion at Timsbury will be cited as setting forth the influence of air-compression in a mine quite free from fire-damp.

In the evening of the 6th of February last, seven men were engaged in making road repairs on the through road between the Upper and the Lower Conygre pits, and on the roads in the Top Little vein, which joined the through road at a point about half-way between Upper and Lower Conygre. About half-way between this

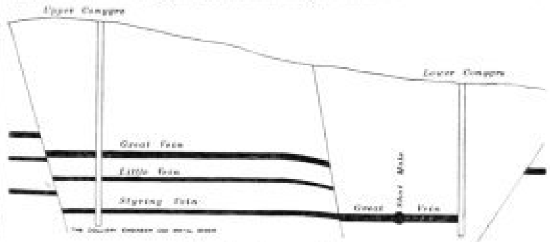


FIG. 2. CONYGRE PITS.

junction and the Lower Conygre pits, an experienced man named James Carter had to prepare and fire a shot to make more height for the horses. His instructions were to charge and fire a hole having a depth of only 13 in., which had been drilled in the roof some years previously. John Gage, an examiner, who lost his life, was to examine the place before Carter charged the hole, and doubtless did so. Carter was warned by G. Flower not to use the clay out of the road for tamping, because it was saturated with oil which had dropped from the trams and contained coaldust, and also because when he used a similar mixture at Camerton twenty years before, it filled the heading with flame. Whether Carter observed these instructions cannot be stated with accuracy, but when his body was found he had two lumps of this oily clay with him. The road was neither dry nor dusty, because on the 29th of January 200 to 300 yards of it had been watered preparatory to firing two shots on the 30th of January and two others on the 2nd of February. All of these shots were within 30 to 50 yards of the shot fired by Carter. The current of air passing along this road at the time of the accident was estimated to have been about 10,000 ft. per minute, with a velocity of 6 ft. per second. The shot-hole had a diameter of 1¼ in., and about 5 in. of its length was believed to have been filled with gunpowder and 8 in. with tamping. About nine o'clock two men who were at work near the West pit at Lower Conygre noticed smoke, and also a brattice door move, and proceeded to ascertain its origin, but as they could not get further than 40 yards along the through road, they returned to the pit, where they were met by the undermanager and bailiff, who had been warned that something was wrong by the engineman at Upper Conygre, who had heard a noise and had also seen smoke thick with dust coming from the top of the pit. Carter's body was found in a kneeling position in a manhole about 80 yards on the in-bye side of where he had fired the shot, and it is interesting to note that the man who fired the fatal shot at Camerton was also found in a similar position, and in both cases the men were severely burned.

DAMAGE BY CARTER'S SHOT.

On the out-bye side of Carter's shot very little damage was done, and even the ventilation doors near the pit were uninjured, but inbye there were heavy falls on the road, the doors and trams were all blown towards the Upper Conygre pits, near which four horses were killed and their hair singed, and two men were also killed and burned. One of these who was near the Upper Conygre

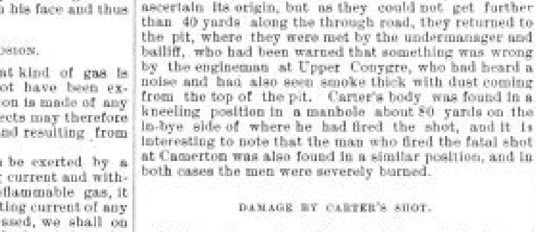


FIG. 1. LLANERCH COLLIERY.

downcast had a leg broken, and his clothes torn off and carried fifteen yards away.

About half way along the through road the intake air was led round through the Top Little vein workings and brought back again into the through road, about 40 yards further inbye, the separation of the two air-currents being affected by a pair of wooden doors placed in the through road. It is quite clear that the highly-heated gases from the after effects of Carter's shot could not freely expand and escape by reason of these doors and of the trams which were standing close by in the siding at the top of Peter's incline, and therefore whilst sufficient energy was being generated to force these doors a distance of fifteen yards, the whole power of this great air compression fell on the Top Little vein workings with the result that all the doors in the gate roads were driven inwards for distances varying from 15 to 30 yards, four men were killed instantly (three of them being severely burned), and small patches of coaldust were found in three places only. With respect to the question of burning, Mr. Martin, the inspector of mines, says that the indications of flame were few, and only noticeable in the places already referred to. After the doors in the through road gave way, the free expansion of the explosive force was further opposed by the devious character of the road, the small diameter of the shafts, and by the cages in the shafts. These cages must have been lifted up the shafts some distance, and then when falling back and brought to a sudden standstill by the ropes caused such a jar as to break several teeth out of the cogwheels of the winding engine and thus render it useless.

THE CAUSE OF THE EXPLOSION.

As the originating cause of the accident was undoubtedly the shot fired by Carter, it remains to be discovered why the effects were so widespread and fatal, when blasting had been carried on in the mine without any particular precautions for a generation and without disaster.

One of the first queries which suggested itself to the writer was in respect to the quality of the powder, particularly as the same make of powder was in use at the Camerton Colliery at the time of the explosion there on the 13th of November, 1893. It has, however, been proved by actual analysis that this powder was of much better quality than the miners' blasting powder which is ordinarily used in coal mines; it was, in fact, a loose powder, of the size of rifle grain, and had the following composition, viz.:

Nitrate of potassium	72.3
Sulphur	11.3
Charcoal	15.3
Moisture	0.9
	100.0

For this anaylsis, and also that of the oily clay to be referred to later on, the writer is indebted to the courtesy of the consulting engineer of the Timsbury Collieries, Mr. John Batey, C. E.

The heat produced by the explosion of ordinary miners' blasting powder, when confined, is about 2,225 degs. Cent., and that of Government rifle grain—which in composition more nearly approaches the powder in question—3,340 degs. Cent. As part of the heat created by the combustion of the gunpowder used by Carter would be expended in breaking down the small piece of rock which was detached from the roof by the shot, it may be assumed, as was done by the analyst, that the heat of the gases set free was about 2,200 degs. Cent. and that the volume of these gases was 21,700 cubic inches.

CARTER STEMMED WITH OILY CLAY.

Carter is suspected of having used the oily clay, two lumps of which were found near his body after the explosion, for tamping his shot, and therefore this was also analysed, and it was found that when it was heated up to 500 degs. Cent., in a closed vessel, and measured at 0 deg. Cent., and 760 mm. barometer, it evolved 100 times its own volume of gas, and that this gas consisted of an inflammable mixture H, CO, CH_4, and CO_2, ethylene, and vapors of some of the heavier hydrocarbons. This oily clay was so inflammable that it was easily ignited by a match when produced at the inquest. Thus we find that we have very highly heated gases from fired gunpowder projected into the intake air in the same direction as that of the air-current, and therefore exerting the very large unused force of the powder to push that current along at a very highly increased velocity. At this point it is to be noted that the combustion of powder is not an instantaneous action, and therefore so soon as sufficient force has been developed to overcome the line of least resistance, the rest of the charge completes its combustion outside the shot-hole, and therefore in the mine atmosphere. The agitation of the air-current caused by this action would, as a matter of course, disturb any fine dust within reach of its flame and vibrations, and particularly that which had been unknowingly collecting for many years in a hollow place above the roof timbers, only 8 yards from the shot. This dust would at once become mixed up with the inflamed gases from the powder, as well as with those distilled by the heat from the oily clay of the tamping, and likewise of the roadway also, and the whole of this mixture would become the basis of another explosion. Doubtless this large volume of explosive material was ignited either directly by the residual heat of the powder charge, or from this heat inflaming the oily clay and some powder which would doubtless be spilled in charging the shot-hole.

THE INTENSITY OF THE SECOND EXPLOSION.

The intensity of this second explosion would be very great, because all the ingredient parts were gaseous excepting only the dust, and as a consequence of the resistance afforded by the force of the incoming air-current backed up by a door near the shaft, by the small diameter of the shafts and the winding cages, its force would be exerted on the line of least resistance, viz., the air-current passing inbye. These influences were further strengthened by the fact that this second explosion took place close to the foot of Peter's gug or incline which rising at a sharp angle, crossed a 70-fathom fault and offered a natural and upward course for the expanding and explosive gases, until they met with further resistance at the top of the incline, where the full and empty trams in the siding, the jig drum, and the pair of wooden doors beyond offered such a strong opposition that the accumulated pressure was driven still further uphill into the Top Little vein workings. This effect continued until the double doors gave way when the pressure at once commenced to decrease, and the pent-up and highly-heated products of combustion quickly found a vent by escaping like steam out of a safety valve at the Upper Conygre pit shafts.

By this description of the probable progress of the explosion and its after effects, it must be understood that the speed of the explosion from the moment of the second or incubatory explosion is calculated to travel at a speed nearly approaching to that of detonation, and that this speed is attained as a consequence of the high and sudden compression of the air-current created by the initial explosion or blown-out shot, which so compresses the air that it detonates the oxygen in the presence of nitrogen, coal-dust and watery vapor, and that consequently as soon as the compression stage is complete the explosive effects also cease.

That this explosion, and also that at Camerton, was not one of coaldust in the sense in which such explosions are popularly supposed to take place, is amply proved by the experiments made by Mr. Henry Hall, which showed that the coaldust from the seams of the Radstock coalfield could not be directly inflamed or exploded by the firing of gunpowder.

COAL DUST DOES NOT EXPLODE.

The next case to be quoted is that of the explosion at the Albion Colliery on the 23rd of June, 1894. Here the conditions were entirely different from those of the last case because Mr. Hall's experiments with gunpowder fired in the presence of coaldust from this mine had already proved that it was the most easily inflamed, and also the most explosive of all the coaldusts tested by him.

For the purpose of the present argument it will be assumed that the explosion originated at the point on Grover's level selected by Mr. Robson and the other inspectors of mines who reported on this accident, and that the originating cause was as they supposed it to be, viz., the flame from a gelatine-dynamite or gelignite cartridge fired either in the arm or in one of the legs of a setting of timber which was being taken out for the purpose of renewal. The heat developed by gelatine-dynamite is stated to be 3,220 degs. Cent., or 5,828 degs. Fahr., and of the products of detonation 46 per cent. to be again combustible and 54 per cent. incombustible; it is therefore clear that the explosive will produce a large volume of very hot flame. Whether the flame ignited both gas and dust above the timbering or only the dust on the floor of the roadway is not of much importance, as similar results might follow in either case. An accident which happened in North Staffordshire will show how easily certain coaldusts may be ignited. At the mine in question the men were driving a heading, and a shot hole was drilled in the ordinary way about 10 in. above the floor, 3 ft. 6 in. deep, about 2 in. in diameter, and charged with nearly a pound of blasting powder. The ventilating air-current was blowing straight onto the shot-hole, and was free from gas. The shot was fired by a squib, but after the contractor had lighted it he found that he had forgotten to take away the dust from the front of the hole and warning his mate, they covered themselves up as well as they could, but even then got a severe burning. Another man who was 50 yards away on the intake side was very badly burned, although he was dressed ready to go out of the pit. As this shot did its work very well, it is clear that the ignition of the dust was caused by the squib or by flame escaping through the squib hole.

If then a so small and comparatively cool flame, when compared with that of gelatine-dynamite, will ignite coaldust, it is not to be wondered at that an explosion such as that at the Albion Colliery should be originated in the way suggested by the inspectors. A space of about 90 yards on either side of the shot presented no indications of great violence, but within it was developed the great mechanical force and tremendous air pressure which constituted the principal factor in carrying destruction into every corner of the mine. There was, however, another factor which comes into the account, and which may have exercised an important place in the effects produced, and that was the firing of one out of five shots in some timber about 120 yards further inbye by the flame or by a detonating vibration from the first shot.

Within a radius of 165 to 275 yards inbye of the first shot the dismemberment and bodily injuries were extremely severe, and further inbye the scorching and coking effects in Nos. 1 and 2 districts were more evident than in any other part of the pit. Seeing that all the heavy coking effects were at or near the coal face and not on the main roadways where they might have been expected to be found in conjunction with the greatest dust and heat, it seems to be convincing proof that the effects where those due to the spontaneous combustion of coaldust in the presence of highly compressed oxygen and not actual flame. When we turn to other districts of the mine we find no coking indicated in No. 3 district, but one case of the scorching of timber in James' heading and one man with his limbs torn off at the junction of Serjeant's and Dudson's headings. This case is very remarkable when considered in conjunction with another case in No. 7 district, where a head and a foot were torn off. Both cases were at a distance of 76 chains from the shot on Grover's level, and both were in the immediate neighborhood of ventilating doors. It would appear, therefore, that when the ventilation doors gave way under the great air pressure, the sudden rush and expansion of air caused the mechanical effect which produced the mutilation.

In the working places furthest away from the pit in No. 4, and likewise in Nos. 6, 7 and 8 districts, coked dust was found on the timbers, but in No. 5 or Pant Ddu district no heat or coking effects were reported. Although nearly all the men were asphyxiated in this dip whilst endeavoring to escape, the horses left by these men in the workings were found alive and unhurt.

If this explosion had been one in which coaldust was the principal explosive agent, it would naturally follow that the afterdamp resulting from its incomplete combustion would contain a large percentage of carbon monoxide, but in this case there is no evidence to show the presence of any appreciable quantity of this very poisonous gas. Fortunately, through the very careful investigations and observations of Dr. J. Shaw Lyttle, of Cilfynydd, and his assistant, both of whom went down the pit to afford immediate relief to the unfortunate people, assisted also, a few days afterwards, by Dr. Haldane, of Oxford, who is well known from his investigations into the effects of CO and CO_2 on the human system, it is possible to throw some strong inferential light on the character of the explosion as well as on that of the afterdamp, and to show that these were primarily influenced by the great and sudden air compression exerted by the first stage of the disaster.

Commencing from the shot on Grover's level, the people for nearly 100 yards on either side of it were, as at Altofts, almost instantly killed although only slightly burned. Whether the cause of death was "shock," "excessive air pressure" or "asphyxiation" cannot be asserted with confidence, but the result in every case was almost instantaneous death.

Further inbye there was more burning and mutilation than nearer to the shot, but equally sudden death. Outbye near the junction of Dudson's heading with Grover's level, ten dead, and three living persons were found. Of these one died almost immediately, another was found badly burned and with both arms fast under his horse, and both fractured. With respect to the above cases D. Lyttle remarks that they showed no symptoms which could be put down to afterdamp. Coked dust and scorched timber were only found in the working-places at the extreme end of the level.

Exigences of space forbid the insertion of details showing the effect of the explosion on human life along the same line of fire in the Cilfynydd level. Evidence shows the erratic effects of the explosion from end to end of this almost straight line.

EFFECTS OF THE AFTERDAMP ON THE RESCUERS.

The effect of the air of the mine on the rescuers was in almost every case to make the eyes smart, to cause great thirst, and to very considerably affect the speech of everyone.

William Gamett who went down in the first cage described the burning smell as "sulphury" and the effect of the air was to make them faint, dizzy, and sleepy. The smell in the returns was described as being like matches and like flannel which had been burning, and had been put out again.

Dr. Lyttle's assistant was suprised to find that all the injured men from Grover's side seemed to lose consciousness and would not readily answer questions when taken out of the pit.

THE COMPOSITION OF THE AFTERDAMP.

It is possible from details that have been made available, to arrive at some general symptoms from which the composition of the afterdamp may be inferred from its effects. Every part of the pit shows that whatever the percentage of carbon monoxide present in the afterdamp, it must have been less in volume than the half of of one per cent., because men were found alive on the direct line of the blast, and in many places far removed from one another the men gathered in groups in their endeavors to escape.

Dr. Haldane examined the blood of some of the horses for carbon monoxide, and as in the cases of human beings examined by him, no trace of carbon monoxide could be found.

If then this gas is only present in such an insignificant quantity that its presence is neither indicated in the blood of human beings or animals, and also that persons are brought out of the pit alive after being in the direct line of the explosion effects, what gas or gases are those which produce the extremely serious head symptoms described by Dr. Lyttle? The descriptions given by the two survivors Howells and Blumford cannot be relied on with confidence, when it is noted that neither were fully conscious when found by the explorers, and that none of the other survivors could recollect anything which occurred on the day of the explosion. Now if this and many other explosions are considered from a new point of view, which has already been suggested in the course of the foregoing descriptions, namely, that the explosion is really one of compressed oxygen, which may have a velocity of high detonating speed, it is not difficult to imagine how some of the conflicting indications immediately become intelligible.

HOW COMPRESSION PRODUCES AN EXPLOSION.

The course of events that would produce compression are: (1) A shot of some flame-producing explosive, either properly or improperly tamped. (2) A blown out shot, or an over-powdered shot, or a large and very hot flame from the insufficient tamping of some high explosive, which produces a large volume of carbonic oxide gas, and therefore a large and very hot flame outside the shot hole after the shot has done its work. (3) A considerable area of the mine roadway filled with the normal quantity of fine dust always present in the air of a dusty mine, added to that which may have been disturbed from the floor, sides and timbering by the air vibration set in motion by the shot. (4) The explosion of this mixture of dust, air and inflammable gases from the explosive, which considered as a shot would be equal to the cubic contents of a cartridge 150 yards long, and having an area equal to that enclosed by the perimeter of the roadway, and ignited by the residual heat of the explosive or by the actual flame from some of the partly inflamed or unconsumed portions of the explosive. (5) The compression of the whole of the air within the mine and its ignition or detonation by the explosion.

The experiments made by Mr. Henry Hall, H. M. inspector of mines, proved the correctness of the fourth sequence, but were not on a sufficiently large scale to show the effects of the fifth. From observations made by Dr. J. Shaw Lyttle, it is evident that afterdamp cannot be largely composed of carbon monoxide, as has been assumed in the absence of actual proof on the contrary, but that there is some gas or gases in the afterdamp which are of a deadly nature is also fully demonstrated, and therefore it remains to be discovered what these gases are. The principal indication in the afterdamp at the Albion Colliery was the irritation of the throat and eyes. At Camerton Mr. Garthwaite said, the air was "suffocating, pungent and irritating," and Mr. Stuart referring to the same explosion, says that it was a significient fact that carbon dioxide could not be detected in the path of the explosion.

If then no carbonic oxide could be detected in the case of the Albion explosion, and no carbon dioxide could be detected in the case of the Camerton, and as both cases are accepted as being examples of coaldust explosions, it becomes necessary to ascertain as soon as possible what part coaldust really plays in what are now called coaldust explosions.

The writer suggests that the indications he has given, point to one general conclusion, namely, that coaldust does not enter into combustion during the outward progress of the explosion, and afterwards it passes through a stage of partial distillation due to the residual heat of the explosion. This suggestion appears to be strongly justified by the finding of coked dust and moreover the only cases of coked dust found were in the Top Little vein workings at Timsbury, where the residual heat would remain for the longest time, because it was at the highest altitude.

The writer now suggests that the fatal gases are oxides of nitrogen, and he does so with very great confidence, because some years ago, after suffering from this irritation on two occasions, he suggested to the late Dr. Camelly, then of Owen's College, Manchester, that it was due to ammonia, the doctor however, did not agree with the suggestion, and took a great deal of trouble to prove that it was almost impossible for ammonia to be formed under such conditions, but that oxides of nitrogen were formed, and caused the irritation, which was distinctly due to these oxides.

EXAMINATION QUESTIONS.

THE MINE FOREMEN'S EXAMINATION IN THE BITUMINOUS FIELDS OF PENNA. JAN. 22, 1895.

Correct Answers to the Questions, Prepared Especially for the Use of Mining Students. Practical Mining Points Explained.

QUES. 14. What special requirements do you consider should be observed in the erection of a ventilating furnace or a ventilating fan?

ANS. In each case due attention must be given to the requirements of an efficient ventilation for the removal of all dangerous gases from the mine; and to secure this result, three special requirements must be secured: first, a sufficient velocity of the current for the removal of gases; second, a sufficient volume to provide sufficient fresh air for each separate district in the the mine; and third, the ventilating pressure must be equal to the resistance due to the air current required.

To secure this efficiency, the fire-grate surface must be equal to the work to be done by a furnace, and in the case of the machine ventilator, the fan must be large enough to obtain the air required by not more than 70 revolutions per minute of the engine.

QUES. 15. How would you proceed legally to guard the health and safety of the miners, and the security of a mine placed under your charge?

ANS. Comply yourself, and see that others do likewise, in carrying out all the provisions of the "General and Special Rules," and all the "Sections" of the Act Relating to The Bituminous Coal Mines of Pennsylvania.

QUES. 16. In a mine where underblasting is required and 75 men are employed, the ventilation is 10,000 cubic feet of air per minute.

Will you then explain fully how many splits you would make and say what velocity the air currents of this mine should have for the removal of black-damp?

ANS. If you are "underblasting" and require to remove black-damp, the quantity of air given namely, 10,000 cubic feet per minute cannot do what is required. Let us first notice Section 2, Article IV of the Act Relating to The Bituminous Coal Mines of Pennsylvania.

"After May thirteenth, one thousand eight hundred and ninety-four, not more than sixty-five (65) persons shall be permitted to work in the same air-current. Provided, That a larger number not exceeding one hundred may be allowed by the mine inspector when in his judgment it is impracticable to comply with the foregoing requirement."

As 75 is ten more than the number that can work in one, or an undivided current, the 10,000 cubic feet of air per minute must be split into two separate currents and say 5000 cubic feet for each, and let the maximum area of section of the current be 35 square feet, then $\frac{5000}{35} = 143 =$ the velocity of the air per minute, such a velocity would neither remove the fumes of the powder nor remove black-damp, because this heavy gas requires a velocity of at least 5 feet per second or 300 feet per minute, to remove it.

QUES. 17. What are the causes of "blown out" shots, and what are the dangers attending them?

ANS. There are several causes of shots being blown out; first, an excessive charge of powder with a short length of stemming is a common cause; second, when the shot hole is too long for the holing; third, when the shortest line from the shot to the face is through the stemming; fourth, when the diameter of the hole is too large for the length of the stemming; fifth, powerful charges in holes of large diameter, blow out more frequently than when the diameter of the hole is properly proportioned to the charge.

The dangers arising from these shots are caused by the long tongues of flame; they project very often into explosive mixtures of gas and air, and the blast of these local explosions often sweeps up large quantities of coal dust, that saturates the fresh air with fuel for further ignition, and so the danger augments.

QUES. 18. In your opinion is it necessary or desirable to maintain the ventilation of a mine when it is idle? Give your reasons in full.

ANS. Even when no cattle are stabled underground the ventilation of a mine ought to be continued when it is idle.

To prove the importance of this conclusion, suppose the ventilation to be stopped for 24 hours; during this period the light inflamable gases will collect in large volumes in all the upgrade chambers, and if any unknown gob-fire exists a destructive explosion will most likely occur when the fan is started, because at that period the fresh air and fire-damp are mixed in explosive proportions, and if this mixture should reach the region of the fire, either by a current or wave motion, a blast is sure to ensue.

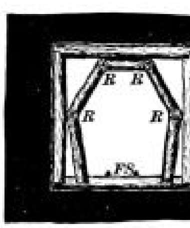
Again several cases are on record where an explosion has occurred in the fan house on starting the ventilation after a stoppage; and indeed an explosion would travel down the upcast shaft into the mine, from a light in the open air in the neighborhood of the fan at bank.

Again the gases that accumulate in the chambers and the gob are sluggish and difficult to remove, and it is always at the periods of removal that dangerous mixtures are made, consequently after a fan has been standing for 24 hours, the mine is not safe some hours after it has started again. Therefore the ventilation should not be stopped when the mine is idle. Section 3, Article IV of The Act Relating to The Bituminous Coal Mines of Pennsylvania, provides that:

"All ventilating fans shall be kept in operation continuously night and day, unless operations are *indefinitely suspended*, except written permission is given by the mine inspector of the district to stop the same," etc., etc.

QUES. 19. Explain and show how you would set props, both in a level and in a pitching coal vein. Also explain with a sketch how you would frame a double set of timbers.

ANS. A prop will carry the greatest weight, or resist the greatest compressive strain, when it is shortest, and, therefore, lies in the shortest line between the floor and the roof. I would, therefore, set props both on a level and on a pitch at right angles to the roof and the floor. The sketch shows how to frame a set of double timbers to resist a considerable side pressure. It will be seen that the principal set is made of notched timbers, and that it is inset with lighter timbers all tied at the top and side butts with longitudinal ties, as at *R, R, R, R.*



QUES. 20. How do gob fires originate in coal mines, and what are the best means of extinguishing them, and how would you guard against them?

ANS. Gob fires are the result of spontaneous combustion, or fire produced by chemical action. Some chemists assert that the initial cause must be sought for in the oxidation of coal, but carbon has never been known to ignite or oxidize in oxygen, excepting at a higher temperature than the ignition one of sulphur; there can therefore, be no doubt that the initial chemical action takes place in the presence of oxygen and sulphur. Rotten timber that has been saturated with sulphurous mine water and afterwards dried, takes fire, and has been known to be a prime cause of a gob-fire.

Gob-fires that cannot be treated with water, can only be extinguished by isolation from the oxygen of the air, and to cut them off from the air they are surrounded with barriers of clay or sand, and where possible and convenient they are isolated with double stoppings, packed close in between with clay.

To guard against them, above everything take care that no timber is left in the gob.

QUES. 21. What should be the volume of air for a mine producing 1,600 tons of coal per day, and what would be the effective horse power of the ventilator with a 1 inch water-guage?

ANS. As the legal allowance of air per man would not be sufficient to dilute and remove dangerous gases, the volume of air should not be less than 200,000 cubic feet per minute, and the effective horse power of the ventilation would therefore be $\frac{200,000 \times 1 \times 5.2}{33,000} = 31.5$ H. P.

QUES. 22. If you were employed to manage the inside operations of a new coal field, how would you proceed with the development so as to cause no loss of coal, or the mine to be over run with creep, and also to secure the health and safety of the employes and the security of the mine property? Answer fully.

ANS. Before this question could be answered by a practical man he would insist on seeing the portion of the mine available, and then he would furnish a correct and satisfactory answer.

As no particulars are given of the thickness or depth of the seam, the hardness or softness of the coal, the nature of the roof and floor, the pitch of the vein, the wetness or dryness of the strata, or the approaches to the seam by shafts, tunnels, or drifts, and as there has to be "*no loss of coal*," and the candidate has to "*Answer fully*," the only reply that can be given by a shrewd miner who is master of his subject in theory and practice and is fit therefore to be a mine foreman, is, No answer can be given.

QUES. 23. What rule would guide you in laying off the workings in a new mine property, so as to obtain a large percentage of lump coal, with an economical use of props, timbers and road material?

ANS. It is a general fact that where the pressure is set unduly on the props, it also falls unduly on the coal and crushes it, and further, when the system of working does not suit the natural conditions, more working places are required for a given output, and this renders the use of more road materials necessary.

The rule that would guide me would be to advance up-grade with the long-wall face in soft bituminous coal, and in breast and pillar I would drive the breasts up the pitch, and thus prevent the crush of the pillars in advancing up grade in their removal.

The treatment required in the extraction of the bituminous seams, is different to that required for the anthracite ones.

QUES. 24. If you were employed to manage an old mine over-run with creep, and the road ways were in a dangerous condition, and the drainage and ventilation were very defective, how would you proceed to improve the condition of the mine?

ANS. Neither the drainage nor the ventilation could be improved until the creep was stopped, because the levels of the water course would be continually altering, and no stoppings or doors could be kept airtight. Again, the return air-ways could not be kept open, because the floor would be lifting, and the roads closing, and if the seam produced much fire-damp no one would be safe in the mine, and if it was over-run with creep, it would cost more than the mine was worth to stop it, therefore the best course would be to let the mine alone until the creep subsided.

The Fire Boss' Examination.

QUES. 1. What are the lawful duties of a fire boss?

ANS. The lawful duties of a fire boss are fully set forth in The Act Relating to The Bituminous Mines of Pennsylvania, as in Article V, Section 1, 4, 7, 8; Article VIII, Section 5; Article XV, Section 1; Article XX, Rule 9.

QUES. 2. How would you ascertain if a safety-lamp is in proper and safe condition for use?

ANS. When the lamp station is at the surface, I would first examine the meshes of the gauze cylinders, to see if they were free from broken wires, soot, coal dust and oil flakes; second, I would examine the asbestos packing rings to see if they were in good order and capable of making an air and gas tight joint; third, I would light the lamp and see that all the parts were in their place, and that the screw joints were tight; fourth, I would test the lamp in the tester provided for that purpose.

QUES. 3. In what part of a mine and under what conditions would you expect to discover explosive gas?

ANS. At the face of a breast or chamber advancing upgrade, or in the cavities of the fallen roof, along the edges of goaves, in all up-grade workings, and in the return air currents, and especially when the volume of the ventilating current is not sufficient, or the velocity of the current is too slow for mixing with, and carrying off the fire-damp.

QUES. 4. Is it any safety in gaseous mines, to have a furnace with a high double arch (or in other words) a large space above the furnace fire leading to the furnace shaft?

ANS. Yes the high double arch of a furnace allows the return air of the mine a free and unobstructed passage into the shaft, and thereby reduces the resistance, and increases the volume of the air per minute circulating round the mine.

QUES. 5. What would be your method of preventing an accumulation of explosive gas, in the worked out parts of a coal mine?

ANS. I would ventilate the gob, by allowing fresh air to have free access to the bottom or lowest edge, and have a return airway running along the top edge of the gob to carry off the lighter gas as it ascends.

QUES. 6. Under what conditions would the use of open lights be safe in gaseous mines, and under what conditions would you forbid the use of open lights in such a mine?

ANS. If the mine is *gaseous* open or naked light can never be used, and on the authority of The Act Relating to the Bituminous Coal Mines of Pennsylvania, Article V, Section 5, I would forbid them for the reasons herein given.

"All entries, tunnels, airways, traveling ways and other working places of a mine where explosive gas is being generated in such quantities as can be detected by the ordinary safety lamp, and pillar workings and other working places in any mine where a sudden inflow of said explosive gas is likely to be encountered (by reason of the subsidence of the overlying strata or from any other causes), shall be worked exclusively with locked safety lamps. The use of open lights is also prohibited in all working places, roadways or other parts of the mine through which fire-damp might be carried in the air current in dangerous quantities.

QUES. 7. Are there any circumstances under which you would not enter on the record book, gas found by you in the morning?

ANS. According to the provisions of the Act, Article VI, Section 8, there are no circumstances under which you would not enter on the record book gas found in the morning.

QUES. 8. At what velocity should the air-current move through the workings of a mine generating explosive gas?

ANS. The velocity should never be less than 5 feet per second, or 300 feet per minute in the working places.

QUES. 9. How many men would you set to work in a section of a gaseous mine passing 1,200,000 cubic feet of air per hour, and discharging 1,500 cubic feet of gas per minute?

ANS. The air returning from this section of the mine, already contains 7.5 per cent. of fire-damp as

$$\frac{1,500 \times 100}{20,000} = 7.5 \text{ per cent. of gas for } \frac{1,200,000}{60} =$$

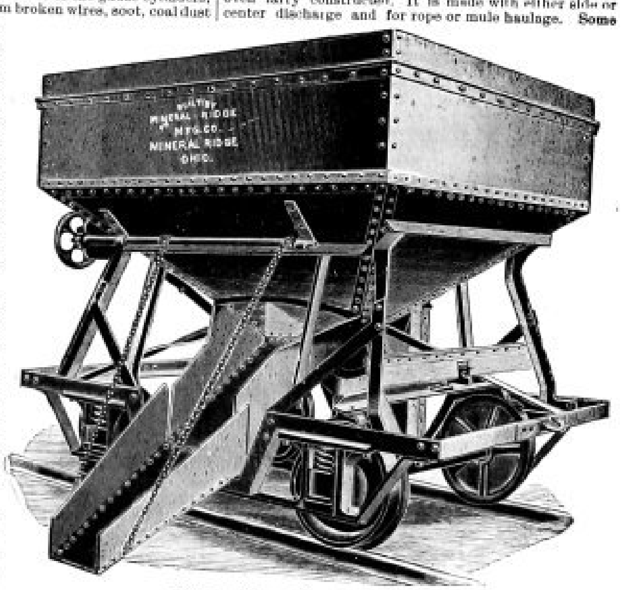
20,000 cubic feet of air per minute, and as air and gas mixed, only cease to be explosive when the percentage of gas is 6.6. I would forbid any men working in the mine when the percentage of gas 7.5 makes an explosive mixture.

QUES. 10. What are the dangers usually encountered on entering a mine after an explosion and how would you proceed to overcome them? Explain fully.

ANS. The first danger arises from the fallen roof, and the broken timber; the second arises from the disarrangement of ventilation by the blowing up of overcasts, and the blowing out of stoppings; and the third arises from the danger of inhaling after-damp. By carefully proceeding to clear away the falls from the roof, and securing the roads with timber, the first danger can be minimized, and the second and third can be prevented by observing the following rule "Take care to travel with the wind, but never against it."

An Improved Coke Oven Larry.

We illustrate herewith an improved Coke Oven Larry, manufactured by the Mineral Ridge Manufacturing Co., Mineral Ridge, Ohio. It is claimed to be one of the most efficient and most durable, if not the best coke oven larry constructed. It is made with either side or center discharge and for rope or mule haulage. Some of the largest producers of coke in the country use them in preference to any other type of larry—one firm alone, The Rochester and Pittsburgh Coal & Iron Co. has bought thirteen of them in the last four years, and Mr. L. W. Robinson, the General Manager of the company speaks of them in the highest terms.



MINERAL RIDGE COKE OVEN LARRY.

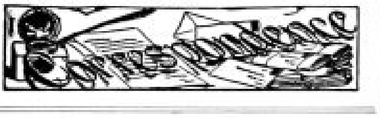
The larries are built under the supervision of Mr. Theodore Thomas, who has had fifteen years experience in the manufacture of all kinds of coke and mine supplies, and who has given the question of the construction of an efficient and durable larry a great deal of study. The Mineral Ridge Manufacturing Co. report that they are receiving orders from every state in the Union, and are even exporting these larries to Mexico. They use nothing but the best iron and steel in their construction and nothing is left undone to make them, as is indeed all their mine equipment, first-class in every respect.

Their shops at Mineral Ridge are equipped to construct anything in the line of tipples, either iron or steel, mine cars, car wheels, drums for self-acting planes, or in fact anything that is needed in the line of mine equipment.

It will pay our readers to write them for estimates when in need of equipments in their line.

Storage Batteries.

Experience seems to show that the use of storge batteries in central stations, affords a certain flexibility which makes them a desirable adjunct to the generating machinery and as this has become generally recognized, it has resulted in their adoption not only in central stations, but also by several of the larger manufacturing concerns in connection with their own power plants.—*Chas. T. Rittenhouse in Electric Power for December.*



This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ *Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.*

Questions on subjects not directly connected with mining will not be published.

MINING REVIVAL IN COLORADO.

Leadville Celebrates it in a Novel and Attractive Manner.

Editor Colliery Engineer and Metal Miner :

SIR:—Leadville is on the threshold of an era of prosperity greater than in its history. Its output for 1895 is in excess of any of the preceding thr.e years, and the value of the output for the year just closed shows an increase over 1894 of nearly 50%. There are 3,800 men employed in the mines, smelters and allied industries of the camp. A great deal of the earnings of the mine employes are going back into the mines through leases, properties that have been idle for years being operated now on leases by pools. Leasing is a feature now peculiar to the camp, the lessees ranging from small groups of miners, whose capital is their labor plus the grub stake of friends, to the big companies who have plenty of means to undertake a proposition of any calibre, and who employ many hundreds of men. The camp is on a sound footing without any boom, and an idle man is a *rara avis*. Even the store-keepers have caught the spirit of enterprise, and every dollar they can spare from their regular business goes into a leasing company. Things are very lively in the gold belt. The Ibex groups are making a steady output, the tonnage for 1895 being 47,000 tons of silicious ore, and development work keeps on with occasionally new discoveries. Other mines in the gold belt are making shipments, while numerous others are being exploited. Every foot of ground that has any mineral indications whatever is being located, and every now and then a new strike is reported. In the old silver contacts a steady and increasing out-put of silver ores is noted, and considerable underground exploitation goes on with results, so far, of exposing large bodies of ore, especially of carbonates. The Sears placer field has in the past year added a number of producers to the camp, and the "Down Town" district is not behind in assisting in the general revival. The smelters are running to near their full capacity and two idle smelters are to start up in January. Leadville is operating chiefly on its home capital and the camp is not seeking a newspaper boom, but it is just the same, in a healthy flourishing condition and will celebrate its recovery from the silver slump with a Winter Carnival. Probably no American mining community has ever had a similar jubilee on so grand a scale as that which surrounds the Ice Castle and which continues throughout January, February and March in a continuous series of entertainments, winter sports and rational revelry. It is under the auspices of the Chrystal Carnival Association which has erected a palace of ice at a cost of $25,000 and entered into an additional expense of $25,000 for the entertainments. The Director General, Tingley S. Wood, is a leading mine operator and has been mining in the Carbonate camp for nearly 18 years. The affair has a distinctive flavor of miners' enterprise, and starts out with appropriate eclat. The ice castle is a thing of beauty and will be a veritable Kobolds grotto of winter hilarity, though instead of being subterranean, it is situate on a ridge extending out from Leadville and among the clouds, 10,200 feet above sea level. The officers of the Chrystal Carnival Association are T. S. Wood, Director General; Chas. T. Limberg, Vice Pres; Wm. T. Temple, Secretary; and Frank X. Hogan, Treasurer. At the back of the association are the successful and wealthy miners of the camp.

Yours, etc.,
SIR KNOCKER.

Injustice of Mine Laws to Citizens of Other States Locating in Pennsylvania.

Editor Colliery Engineer and Metal Miner :

SIR:—As my subscription for your valuable journal expires with the present month, I beg to give notice that I do not intend to renew it.

I regret the necessity for this step, but I do not feel justified in devoting any more time to the study of a profession I cannot enter. The mine laws of Pennsylvania deny me one of the privileges of American citizenship in refusing to allow me to compete for a mine foreman's certificate, because I have not worked five years in Pennsylvania mines. I am without the influence, absolutely necessary in order to secure a position as mine superintendent, (which does not require a certificate), and I have no intention to return to the coal mines as a fire boss, for which I have a certificate, consequently, as I must remain outside of the only occupation I can truthfully claim to be familiar with, I have no longer any inducement to study.

My apparent inconsistency, in striving to obtain a certificate, or position as mine foreman, and at the same time, neglecting the assistance offered by your correspondence system of teaching the theory of mining, is readily explained by the fact that I was not working in the coalmines a the time, and my future course was uncertain, had it been otherwise, I would be very glad to have such an excellent opportunity to acquire a thorough technical education.

Thanking you sincerely for the interest you have taken in my case, and wishing increased prosperity to THE COLLIERY ENGINEER AND METAL MINER, the best journal I ever read. I am etc.,

Yours very respectfully,
EDWARD HALPIN,
Allegheny, Pa.

The 5th Root.

Editor Colliery Engineer and Metal Miner :

SIR:—As a practical rule for finding the fifth root of a number without the aid of logarithms, has been asked for by men preparing for the Managers examination, I submit this rule to your subscribers:

For numbers less than 32 find the difference between given number and 32 and call it the difference. Place this difference over 80 to form the first fraction. Multiply the first numerator by the difference and place over 6,400 for second fraction. Multiply the second numerator by 3 times the difference and place over 1,024,000 to form the third fraction. Multiply the third numerator by 7 times the difference and place over 327,680,000 for the fourth fraction. Multiply the fourth numerator by 19 times the difference and write over 262,144,000,000 to form the fifth fraction. Multiply the fifth numerator by difference and write over 10,485,760,000,000 for the sixth fraction, etc. Reduce all the fractions to four decimal places and add. Substract this answer from 2 and your answer will be correct to two or more decimal places. If the given number is small use all the fractions. If nearly as large as 32 only two or three are necessary.

Example.—$3^2 = \sqrt[5]{3^2} = \sqrt[5]{9}$. Difference = 23.

$\frac{23}{80} = .2875$

$23 \times 23 = \frac{529}{6400} = .0826 +$

$529 \times 23 \times 3 = \frac{36501}{1024000} = .0356 +$

$36501 \times 23 \times 7 = \frac{587661}{327680000} = .0179 +$

$587661 \times 23 \times 19 = \frac{256810857}{262144000000} = .0097 +$

5th numerator $\times 23 = \frac{5906631971l}{10485760000000} = .0056 +$

6th numerator $\times 23 \times 29 = \frac{39397235247237}{1174405120000000} = .0033 +$

Sum = .4424 + Subtract from 2.

Answer = 1.5575. Correct to two decimal places.

Again, $\sqrt[5]{27}$ Difference is 5.

$\frac{5}{80} = .0625$

$5 \times 5 = \frac{25}{6400} = .0039 +$

$25 \times 5 \times 3 = \frac{375}{1024000} = .0003 +$

Sum = .0668 + Subtract from 2.

Answer = 1.9331. Correct to three decimals.

A similar rule can be given for numbers between 32 and 243.

W. W. TORRY,
Springhill, N. Scotia.

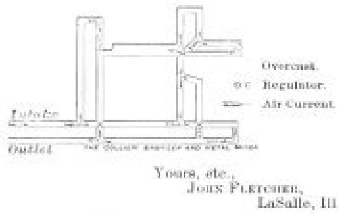
Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—In the December issue of this journal, "Ajax" gives a drawing of double entry system and requests that some of your readers give plans for ventilating the same with the least number of doors and without doors."

I think that Ajax might have showed a few cross-cuts on his drawing between the entries.

I submit the following answer showing how it can be ventilated without doors:



Yours, etc.,
JOHN FLETCHER,
LaSalle, Ill.

What Electricity Can Do.

Some idea of the diversity of uses to which electric motors are now being put and the rapid spread of electricity in different directions may be gathered by glancing at the list of orders for motors received in the Power & Mining Department of the General Electric Company, during one month this summer:

Operating mining machinery, shoe factory, operating a yarn factory; a tannery; a powder mill; a watch factory; iron working machinery; a foundry; hoists for electric cranes; ventilator on a gun boat; propelling electric launches; the operation of elevators; blowing church organs; operating woolen mills.

These orders are scattered throughout the following States: California, Colorado, Indiana, Ohio, Connecticut, Michigan, Pennsylvania, Rhode Island, Wisconsin and New York; Lima, in Peru and Rio de Janeiro in Brazil.

PRIZE CONTEST.

PRIZES GIVEN FOR THE BEST ANSWERS TO QUESTIONS RELATING TO MINING.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for January.

QUES. 199. In the construction of our new safety lamp, do you think we should adopt the principle of the tubular poles that are the distinguishing feature of the Gray lamp. This lamp is preferred for gas testing because it can detect a thin stratum of gas just under the roof of the seam. A shunt is provided in some "makes" of this lamp, to cut off the supply of air down the poles, and admit the supply above the glass cylinder, as in the Marsaut lamp, when it is not required to test for gas near the roof. Now I should like you to answer me three questions to aid me in deciding the point at issue:

First. Why is the supply of air from the poles cut off when the lamp is in ordinary use?

Second. When the lamp is fed with air from the poles, if you give it a quick sudden drop the light goes out. How is this?

Third. When the lamp is carried in air charged with gas, if you move it quickly and suddenly upward, it fills with flame. How is this?

QUES. 200. We are going to prospect for coal, and at first we will only search for indications by examining the exposed rocks, and therefore we must get up in good shape our paleontology, in so far as the fossils that characterize the Silurian, the Devonian, the Carboniferous and the Triassic formations are concerned. Will you then assist us by naming the examples that we ought to know, and give them under four heads:

First. Negative examples, as of the fauna of the Silurian and Devonian series.

Second. Positive examples, as of the fauna of the Carboniferous and Triassic formations.

Third. Negative examples, as of the flora of the Silurian and Devonian formations.

Fourth. Positive examples, as of the flora of the Triassic and Carboniferous formations.

QUES. 201. In M. Murgue's theory of the equivalent orifice, the following equation is given: $A = \frac{A\,Q}{\sqrt{W\,G}}$, and I will be obliged if you will inform me how he gets A for a constant. I know he takes the *vena contracta* at .62 and that A is the square feet in the equivalent orifice, Q is the quantity of air in thousands of cubic feet per minute and $W\,G$ is the water guage.

QUES. 202. We have a seam of coal with a soft wet floor, and the immediate roof is a slate 2 feet thick and it falls. The seam is 4 feet thick, is at a depth of 612 feet, and consists of a soft coking coal lying nearly level.

We have tried longwall working and it has proved a great failure, as the packs sink into the floor. We have 700 acres available and the field is nearly square. The coal is valuable for coke making and we cannot give it up, then will you send us a neat plot of how you would work it. You might locate your shafts in the middle of the field, and give us the sizes of your roads, and pillars, if any.

QUES. 203. The same coal seam is pitching heavy in one region and in another it is lying quite level. The thickness and quality of the coals are however equal in the two cases, and we wish to invest in one of them, which do you prefer and why?

QUES. 204. We have three mines all working the same vein, and we will call them A, B and C. The cover, the floor, and the depth and thickness of the coal are in all the cases about equal and the system of working this 4 foot vein is the same at each mine, and that is longwall advancing. Now the superintendent at A, works on the principle of having plenty of "pit room" or a working face far in excess of that required for immediate use. The superintendent at B keeps no more working face open than is required for immediate use but believes in having all ready for unexpected events. The superintendent at C does not believe in plans for future working, "because" says he, some one may come after him and reap the harvest of his labor. This being a good presentation of the three cases, will you please give them your close attention, and let me know at your earliest how it is that only one of these mines pays the company, while the other two are a "dead" loss, and be careful to say which mine pays, and show the reasons why it does so.

Answers to Questions which Appeared in November and Previous Issues, and for which Prizes Have Been Awarded.

QUES. 175. There is at present a ready market and a good price for fire-bricks; flooring tiles for fire-proof buildings; common bricks for filling and backing; glazed and unglazed facing bricks; sewer pipes and drain traps.

Our Coal Mining Company wish to share in this manufacture and trade, and have desired me to make sample bricks out of the underclays of five different coal seams we are working. I have done so with the following results: Clay of seam *A* makes a hard strong red brick coarse in the grain; Clay of seam *B* contains iron balls, but the dressed clay makes a soft white brick that is very porous; clay of seam *C* makes a soft white brick that is very porous and speckled with blackish brown spots; clay of seam *D* makes a hard coarse grained brick, and of a black and bluish color; clay of seam *E* makes a white brick that is very strong and fine in the grain. Now I desire to know two things to enable me to make a satisfactory report to the company.

First. What classes of goods are each of the clays best adapted for making?

Second. What are the constituents in the clays that give to the bricks their different characteristics?

ANS. *First.*—*A* would make good sewer pipes.

B would make fire-bricks and good flooring tiles.

C would make a very good grade of fire-bricks and could be classed as No. 1.

D would make good filling bricks or would resist atmospheric influences in exposed situations.

E would make good facing bricks.

Second. All clays contain more or less of the following impurities: pottania, sodium, calcium, iron and magnesium.

The best or No. 1 clays contain only traces of these however, and the greater the proportion of the impurities present, the harder are the bricks, and the greater is their fusibility. Such brick are an iron red or brown in color, and when highly heated in burning, have a glassy appearance when cold.

The chief constituents of fire clay are: kaolinite that is infusible and shrinks, and quartz that does not shrink.

J. JENKINS,
Dingess, W. Virginia.

Second, GEO. BROWN,
Falls Creek,
Clearfield Co., Pa.

QUES. 176. Here are two samples of bituminous coals, and in chemical composition they are both alike, and even make cokes that are alike, after they have been ground small and steeped in hot water. Hot water dissolves out of sample *A*, nitre, and out of sample *B*, common salt, and what I want to know is this, what effect will nitre have on the coking of sample *A*, and what effect will common salt have on the coking of sample *B*.

ANS. Along with the nitre in *A*, there will be the bisulphide of iron or pyrites, and these conjointly will render the coal very inflammable and destroy the pitchy binding of true coke. The following experiment fully establishes the fact just noticed: When a carbonaceous substance like wood is steeped in a mixture of sulphuric and nitric acids, and dried, a scratch made on the wood, even with the finger nail causes the emission of flame.

Sample *B* will make a silvery coke because carbon will not burn in chlorine, the common salt being NaCl. It is claimed that common salt in coke desulphurizes it, but the samples tested do not justify this conclusion.

J. J. ORMSBEE,
Henry Ellen, Ala.

Second Prize, CHAS. E. BOWRON,
Tracy City, Tenn.

QUES. 180. The action of one of our mine pumps is very peculiar, and it will startle you when I tell you, that any increase above a certain speed of the piston reduces the lifting power of the pump, and at another increase of speed the pump loses the water altogether. Now as I would like you to explain the tricks of this peculiar pump I will give some particulars. When the pump piston is at the bottom of its stroke, it is 12 feet above the level of the supply water, and as the force to lift the keep valve and overcome the friction of the water moving through the tail of the pump is equal to a two-feet column of water, we may reckon the mean lift to be 14 feet. Will you then tell me two things.

First. What is the highest speed at which this pump can be run to obtain a maximum effect?

Second. At what piston speed does the pump lose the water altogether.

ANS. *First.* The speed of the piston must not exceed the velocity of the entering water, to obtain a maximum effect. A column of water 34 feet long will balance the pressure of the atmosphere. The velocity of water into a vacuum is 40 feet per second, or the square of the velocity per second is 1,600.

In the example the equivalent of the lift is 14 feet; then,

$$v = \sqrt{\frac{(34-14) \times 1,600}{(34+14)}} = \sqrt{\frac{20 \times 1,600}{48}} = 25.81$$

feet per second, the velocity of the water on entering the pump, when the piston attains its highest speed.

Second. If the slip of the valves in the pump is equal to 1 per cent., and the velocity of the piston in feet per minute is $25.81 \times 60 = 1548.6$, then when the piston speed is 100 times quicker than the speed of maximum effect or 154,860 feet per minute, the pump will entirely loose its water.

THOMAS D. SMITH,
Coal Valley, Pa.

Second Prize, DAVID P. BROWN,
Dunbar, Fayette Co., Pa.

QUES. 187. I am still busy with the invention of our proposed new safety lamp, and I still crave for a little of your assistance, which I have no doubt you will cheerfully give by answering the following three questions:

1st. What should be the diameter and length of the gauze cylinder if I use one; or if I use two, as is done in the case of the Marsaut, what would be the best dimensions for each of them, and give reasons why you prefer the sizes you name?

2d. What should be the sizes of the wires and meshes of the gauze, and how many lines should there be to the linear inch?

3d. What is the use of the bonnet or close shield, and should we adopt one in our new lamp?

ANS. *First.* The length of the gauze cylinder should not exceed 6 inches, or the diameter $1\frac{1}{2}$ inches, and where a double gauze cylinder is used, the outside one should be made a little larger to closely cover the one of the dimensions given.

Second. The number of meshes or openings per square inch should be 784, and the lines of wire per linear inch should be 28.

Third. The use of the bonnet is to screen the gauze cylinder from the effects of draughts of wind, that blow the flame through the meshes, and set up a fiery heat by the excess of air and gas that enters above the flame of the wick, or in short the bonnet is to limit the supply of air, to that required for the oil flame only.

JOHN FLETCHER,

Second Prize, JOS. VIRGIN, 428 Tonti Street,
Hollsopple, Pa. La Salle, Ill.

QUES. 188. We are going to try some experiments by exploding fire-damp in a close, strong vessel, made of steel, and strong enough to resist the greatest pressures to which it may be subjected. The fire-damp is a diffusion in which 10 volumes of air are saturated with one volume of marsh-gas. To the steel vessel we are going to attach a pressure gauge, and I will feel obliged if you will tell me what the pressure will be at the moment of the explosion and after the steel shell and its contents or remaining gases have cooled down to the present or actual temperature of the outside air?

ANS. The burning of one pound of CH_4 in air, should produce 26383 units of heat.

The one pound of CH_4 consists of .75 of a pound of carbon, requiring for its combustion 2 pounds of oxygen and .25 of a pound of hydrogen, requiring for its combustion 2 pounds of oxygen, and therefore to burn one pound of CH_4, 4 pounds of oxygen are required, or 17 pounds of air.

Taking the specific heats at constant volume, then the units of heat required to raise the temperature of each of the bodies in the resulting mixture one degree will be as follows:

2.75 pounds of CO_2	$= 2.75 \times .177 =$	.470
2.25 pounds of H_2O	$= 2.25 \times .305 =$	.686
13.00 pounds of N	$= 13.00 \times .174 =$	2.349
18.00		3.505

The temperature of the result will, therefore be

$$\frac{26383}{3.505} = 7801°\ F.$$

By Gay Lussac's law the pressure will then be at the moment of explosion

$$14.7 \times \frac{(459 + 7801)}{(459 + 41)} = 242.844$$

pounds pressure per square inch, and after the contents of the vessel have cooled the pressure will be

$$242.844 \times \frac{(459 + 41)}{(459 + 7801)} = 14.7$$

pounds pressure per square inch.

THOMAS D. SMITH,
Coal Valley, Pa.

Second, J. M. JAMES,
Sioux Falls, S. Dakota.

QUES. 189. We have on hand a ventilating fan that can discharge 120,000 cubic feet of air per minute, with a useful effect of 30 H. P. We are going to sink two rectangular shafts, whose lengths have to be twice their breadths and their areas have to be equal. One of them will be an upcast and the other a downcast for the ventilation, and to prevent a needless waste of energy we wish the shafts to be of such an area that only one-third of the ventilating power, or 10 H. P., shall be necessary to overcome the friction of the shafts. Will you, then, calculate for us the area and the length and breadth required for each shaft?

ANS. $\frac{10 \times 33,000}{120,000} = 2.75$ = pounds pressure used in passing 120,000 cubic feet of air per minute through upcast and downcast shafts. $8 \times 16 = 128$ = assumed area of shafts. $\frac{120,000}{128} = 937.5$ = velocity. Then,

$$\frac{2.75 \times 128}{.0000001 \times 878906.25} = 40,049+ = \text{rubbing}$$

surface, and $\frac{40,049}{48} = 834.375$ = length, or depth of both shafts, and, $\frac{834.375}{2} = 417.5$ = as the depth of each shaft.

Therefore, the area of each shaft is 128 feet, length, 16 feet, breadth, 8 feet and depth 417.5.

THOMAS HUSDON,
Galva, Ill.

Second Prize, JOHN FLETCHER,
428 Tonti Street,
La Salle, Ill.

QUES. 190. We have two airways which we will call *A* and *B*, and they are both 2,000 yards in length, and the air is blown through each of them with a difference of potential equal to 2 inches of water gauge. *A*, however, is 10 feet wide and 6 feet high, and *B* is 15 feet wide and 10 feet high, and as we do not require more air to pass through *B* than through *A*, will you find what quantity is passing along *A*, and what should be the area of a regulator in *B* to pass the same quantity as that of *A*; the *vena contracta* being taken at .65, and *k* at .0000001.

ANS.—Quantity of air flowing through *A* =

$$\sqrt{\frac{p\ a}{k\ s}} \times a = \sqrt{\frac{10.4 \times 60}{.0000001 \times 192,000}} \times 60 = \sqrt{\frac{624}{.00192}} \times 60 = 34,200 \text{ cu. ft. per minute.}$$

The quantity of air passing through *B* without a regulator would be

$$\sqrt{\frac{10.4 \times 150}{.0000001 \times 300,000}} \times 150 = \sqrt{\frac{1,560}{.003}} \times 150 =$$

108,165 cu. ft. per minute; but as only 34,200 cu. ft. per minute are to pass through *B*, the difference of potential for the opposite sides of the regulator will be

$$10.4 - \left(\frac{10.4 \times 34,200^2}{108,165^2}\right) = 10.4 - \left(10.4 \times \frac{1}{10} \text{(almost)}\right) = 9.36 \text{ lbs.}$$

The velocity through the regulator will be

$$\sqrt{\frac{9.36 \times 1,800,000}{2,120}} = 89.147 \text{ feet per second or } 5348.82$$

feet per minute, and allowing .65 for the *vena contracta*, the opening of the regulator is

$$\frac{34,200}{5348.82 \times .65} = \frac{34,200}{3466.733} = 9.8368 \text{ square feet.}$$

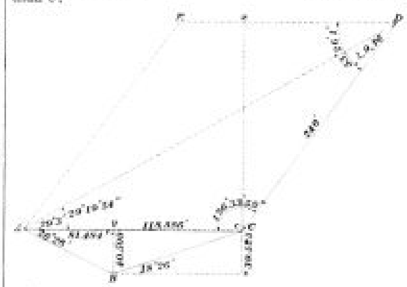
JOHN VERNER,
Lucas, Iowa.

Second Prize, DAVID P. BROWN,
Dunbar, Fayette Co., Pa.

QUES. 191. An important vein of iron-stone is outcropping on a hillside, and I will be obliged if you will calculate for me its height above a point we will call *A*. To reach the outcrop, the nearest course is to descend from *A* to *B* and then ascend to *C*, and from *C* ascend the hillside to *D*. Now *D* at the point *A* makes an angle of elevation of 29° 3′. The distance from *A* to *B* is 91 feet, and *B* makes an angle of depression at *A* of 26° 26′. The distance of *C* from *B* is 125 feet, and *C* at the point *B*, makes an angle of elevation of 18° 26′. The distance of *D* from *C* measured up the side of the hill, is 240 feet. What then is the vertical height of *D* above the level of *A*, when the points *A*, *B*, *C*, and *D* all lie in the the same vertical plane?

ANS.—Point *B* is sin. 26° 26′ × 91 = 40.509 ft. lower than *A*. Point *C* is sin. 18° 26′ × 125 = 39.525 ft. higher than *B*.

Point *A* is .984 ft. higher than *C*.



Solving the right angled triangle *c A C*, we have side *cC* = .984 ft.; side *c A* = (81.484 + 118.586) = 200.07 ft.; we find side *AC* substantially the same length as *cA* = 200.07 ft., and the angle *cAC* to be 0° 16′ 54″.

Solving the triangle *ACD*, we have side *AC* = 200.07 ft., side *CD* = 240 ft. and the angle *DAC* = (29° 3′ + 0° 16′ 54″) = 29° 19′ 54″.

To find angle *ADC* = 240 : 200.07 :: .4898639 : .4083628. .4083628 = sin. of 24° 6′ 7″ = angle *ADC*.

Constructing parallelogram *ACDE*, angles *A* and *D* are equal (53° 26′ 1″ each), angles *E* and *C* are also equal (126° 33′ 59″ each), and we find the length of the perpendicular *xC* to be .8031670 × 240 = 192.760 ft.

Deducting *cC*	.984 ft.
xc	= 191.776 ft.

D is therefore 191.776 ft. higher than *A*.

JOHN VERNER,
Lucas, Iowa.

Second, J. W. CANTY,
Oskaloosa, Iowa.

QUES. 192. What would occur if the force pumps for feeding a boiler were set at an elevation of 5 feet above the level of the feed water in the heater when the temperature of this water was 212° F.

ANS. A violent pounding, the explanation of which is as follows:

Water heated to about 100° Fahrenheit will begin to boil in a vacuum and produce steam with an increasing pressure as the temperature rises, until 212° is reached, when the steam pressure will equal that of the atmosphere. In a pump a partial vacuum is produced in the water end by the movement of the plunger, into which the water flows by atmospheric pressure. Water when about at 212° in the open air will produce steam on the slightest provocation, such as any reduction in pressure.

To force the water into the pumps 5 ft. above, will require a pressure of 5 × .433, or a little over 2 lbs. on the surface of the feed water; or,—what is just the same—a reduction in pressure in the suction pipe of like amount. If the pump is started and this 2 lbs. of pressure removed, the water will immediately boil and produce steam, and we will pump steam instead of water, or steam and water both. On the return stroke of the plunger the steam will be condensed, and any water that has entered will be met with a blow as if from a steam hammer.

J. J. ORMSBEE,
Henry Ellen, Ala.

Second, J. W. CANTY,
Oskaloosa, Iowa.

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TO MANUFACTURERS AND DEALERS IN MINE EQUIPMENT AND MINE SUPPLIES.

THE actual paid circulation of THE COLLIERY ENGINEER AND METAL MINER exceeds by fifty per cent. that of any other mining journal. Its columns are devoted exclusively to the publication of first-class articles on mining methods and mining machinery, and consequently its circulation is limited to mining men. It reaches more mine owners and mine officials than any other publication. Its circulation covers every mining field in North America. Its subscribers are at fifteen hundred and seventy-three post-offices in the United States, British Provinces and Mexico. Its editorial staff and force of paid contributors embraces only men who have had extensive practical experience as well as theoretical knowledge. Its mailing list is open for the inspection of advertisers and prospective advertisers. It is unquestionably the best advertising medium in America through which manufacturers of power plants and appliances, mining machinery, and mining supplies may make their business known in every American mining field. A handsome and useful pamphlet on Mine Equipment and Mine Supplies, containing valuable information and statements from many of the leading advertisers in THE COLLIERY ENGINEER AND METAL MINER will be sent free to any manufacturer or dealer in mine equipment or supplies, on application.

COAL DUST EXPLOSIONS IN MINES.

MR. DONALD M. D. STUART, F. G. S. in a lecture delivered at the Technical Schools, Derby, England, on the above subject said: "An experience of about twenty years in collieries where coal dust abounded, where shot firing was general, and gob fires had sometimes prevailed, had, up to the year 1893, led him to the conclusion that coal dust was harmless in non-gaseous mines." Explosions at the Camerton collieries, where for over one hundred years no trace of gas had been found, deepened in his mind the mystery as to the cause of the explosion. A simple calculation showed that the quantity of heat generated in the explosive that was fired was utterly inadequate to produce the results observed after the explosion. It was only after many months' reflection, and some experiments with coal gas, that the difficulties were removed, and he found that when coal-dust yielded up its gases under the action of heat from an explosive, chemical actions were initiated that provided a solution of the observed phenomena. Upon this basis of fact the conclusion became irresistible, that a disastrous explosion, similar to what occurs in gaseous mines, had been produced by coal-dust alone; and there remained no shadow of a doubt in his mind that coal-dust was an explosive agent.

A more recent explosion at Timsbury collieries, also non-gaseous, which he investigated, presented phenomena identical with those which he had observed at Camerton, and confirmed the conclusions at which he had arrived.

He then turned his attention to explosions in gaseous mines, and found that the phenomena in these explosions corresponded with those observed in non-gaseous mines. He expounded his theory that an explosion in a mine was characterized by numerous local explosions, each disturbance being isolated and preceded by a length of mine passage, in which the materials were practically in their normal state, or had not been subjected to violent forces.

Mr. Stuart illustrated his lecture by stereopticon views of the scenes of explosions in several collieries, showing the places where the disasters were originated, and their subsequent development through the workings. Each disaster was traced to its origin, and the developments of the explosions were shown to be characterized by numerous subsidiary explosions, which left their evidence in isolated exhibitions of explosive violence. He explained the nature of the forces in the explosive disturbances, and in the intervening spaces, and the extent and causes of disarrangement of materials in the latter, and with that qualification he remarked that the fields of disaster in the Camerton and Timsbury collieries exhibited the effects of numerous distinct and violent disturbances, in which doors were shattered to fragments, iron work broken and distorted, trams broken and crumpled and their contents scattered abroad; rails torn from their sleepers, timber fractured and knocked down, arches demolished, stone roof ripped in thicknesses up to 3½ feet, and men mutilated, each disturbance being preceded by lengths of mine passage in which the trams were uninjured and their contents undisturbed, the rails were unmoved, the timber unbroken and undisturbed, the arches undamaged, the roof in its natural state, and the men not mutilated. The energies in the disturbances, and the energies in the intervening spaces, therefore exhibited distinct modes of action.

He also reviewed two other notable explosions and showed that the ruin wrought and the extent of the mutilation of the bodies found in different localities proved his ideas.

With this evidence and numerous other facts of the same definite character, Mr. Stuart formulated the theory of intermittent subsidiary explosions, and that the mystery of colliery explosions must disappear, for it was no longer necessary to suppose that there were sudden and incredible outbursts or accumulations of fire-damp at the moment of the disaster. He stated that coal dust, always and everywhere present in the mines, was capable of giving rise to explosions, and of producing the phenomenon of subsidiary local explosions.

In concluding his lecture, he said, "We have now examined disasters in typical gaseous and non-gaseous mines, and have observed, that in their inception, and in their development, they present an identical rationale that demands for its explanation an identical explosive agent; and as coal-dust is the only agent common to both gaseous and non-gaseous mines, it must have been the common source of the gases that produced the calamities to which he had drawn their attention."

Throughout his lecture Mr. Stuart, naturally treated only with explosions in British mines. His conclusions as to "coal-dust, always and everywhere present in mines" does not apply to anthracite coal mines. The dust may be present, and may to a small extent, when present, intensify a gas explosion in an anthracite mine, but it will not originate an explosion or propagate it. The low precentage of volatile hydrocarbons in anthracite coal renders it freer from dust explosions than the various other classes of coal. In fact this feature indirectly proves the coal-dust theory. Some of the anthracite mines of Pennsylvania rank among the most gaseous in the world, and there has never been a gas explosion in one of them that has not been comparatively local in its effect. In both British and American bituminous mines, however, the case has frequently been different. Explosions of small accumulations of gas have frequently been propagated by dust and carried with varying intensity throughout all, or the major portion, of the mine workings. Sudden outbursts of gas, authenticated by positive proof, have occurred in anthracite mines, and have caused disastrous explosions, but the limit of the explosive force was comparatively small. Such outbursts undoubtedly occur in bituminous seams, and are sometimes the origin of explosions, but we are of the firm opinion that the extent of the workings affected, outside of a limited area, depends entirely on the quantity of dust present, and the chemical composition of the coal.

Mr. Stuart's lecture, which was widely published in Great Britain, has drawn out comments from such other eminent British authorities as Messrs. Arnold Lupton, A. L. Steavenson, B. H. Thwaite, J. W. Ronaldson and others.

Mr. Lupton says, in a recent letter to *The Iron and Coal Trades Review*, of London, that "the explosive nature of coal dust was demonstrated thirty years ago by French experimenters, and the fact was proved conclusively by Messrs. W. N. and J. Atkinson, in their work "Explosions in Coal Mines" published in 1886; but notwithstanding this conclusive demonstration, and the equally conclusive and most striking experiments of Mr. Henry Hall, H. M. Inspector of Mines, there still remained sceptics, of whom some where convinced by the Timsbury and Camerton explosions. I think Mr. Stuart is doing a good work in bringing the matter prominently forward. Mr. William Galloway was the leader among English mining engineers; then followed the Messrs. Atkinson; but it is necessary to have a succession of teachers to bring this truth home to the rank and file."

Mr. Lupton discusses the location of the greatest explosive force in an explosion and says: "It does not seem to me that this is necessarily coincident with the position of the greatest evidence of explosive force. These evidences of force seem to me to be produced by a rushing current, and I can conceive it possible that the greatest rush is not necessarily at the place where there is the greatest intensity of heat or of explosive energy. For instance, supposing the explosion to take place at the end of a heading, there could be no rush of air except in one direction, and I think the rush would be greater at some distance from the end of the heading than close to the end. Similarly, if an explosion took place in the middle of a length of roadway, the explosion travelling both ways, it is to me conceivable that at the point of origin there might be a neutral point from which the rush of air would pass in each direction with increasing violence, although the greatest heat and greatest pressure might be at the point of origin, where no signs, or but slight signs, of violence might be observed."

Mr. Steavenson, in discussing Mr. Stuart's lecture is inclined to be sarcastic. In his letter to our London contemporary, he practically coincides with Mr. Stuart's statements, and calls attention to the fact that the latter's conclusions were not original, but that they are the same as other investigators. He cites a number of authorities to prove this, and quotes as follows from the report of the British Commissioners on Accidents in Mines, published in 1886:

"In discussing the manner in which coal-dust operates alone in propagating flame from a blown out shot, Mr. Hilt does not advance any point of novelty, his views being that, as suggested by Faraday and others, the flame furnished by the dust is due in part to the combustion of the coal-dust itself, and in part to that of the gas developed from fine dust particles by their exposure to heat."

While Mr. Steavenson asserts what is an undoubted truth, he can not detract from the credit due Mr. Stuart for his investigations and the publicity he is giving the facts that he demonstrated to his own satisfaction. As we read Mr. Stuart's lecture, we are impressed with the idea that he is a man not satisfied with hearsay evidence or evidence deduced from the investigations of others. He wanted his own, he secured it, and he gives it publicity. Therefore he is entitled to honorable commendation and we regret that an auther of Mr. Steavenson's ability should attempt to detract from his honor by sarcastic references to former investigators who arrived at practically the same conclusion.

Mr. B. H. Thwaite discusses the subject as follows: "The proof that coal-dust disseminated in air is or is not explosive in the absence of marsh or other combustible gas can only be satisfactorily established by a long series of tests with the dust from coals that have varying content proportions of volatile hydrocarbon and varying degrees of physical fineness."

"I believe that, given that coal-dust is sufficiently fine, even if it is pure carbon, or without the least trace hydrocarbon in its constitution, if it is well disseminated throughout the air, and is in explosive proportion to such air, it will certainly be explosive. We have many examples of explosions in flour mills and in the coal bunkers of steamships. It has not been contended that the presence of gaseous combustible associates was the cause of these explosions. If the explosive proportion of carbon coal-dust ratio to the air is low, and this mixture fills long and attenuated roadways in mines, the flame of the explosion will pass along the roadways, but its full explosive energy will not be immediately developed; the explosive action will be in sequential series, and the violence will depend upon the proportion of the suspended carbon ratio to the air in the different parts of the roadway, and upon the character or form or size of the egress for the escape of the explosive flame. In some proportions, as this egress is contracted, the intensity of the explosion will be increased."

"Anyone who has had experience with the working of long flues for the conveyance of combustible gas knows that the explosions occasionally occurring from condensation along the flues act with varying degrees of energy upon the manhole lids, and the action is distinctly sequential."

It will thus be seen that Mr. Thwaite believes that anthracite dust under certain conditions is explosive. There is a possibility of his being correct, but as previously stated, there has never been a coal-dust explosion in an anthracite mine, and some of them are at times so dusty as to make it impossible to see a light ten yards off.

Mr. J. W. Ronaldson, while not disagreeing with Mr. Stuart's theory says:

"I gather that because evidences of force have been found after an explosion to be, not continuous throughout the area affected, but in apparently isolated sections, Mr. Stuart concludes that there must have been a series of explosions, each one isolated from the others. If this is his argument, I cannot accept it as conclusive until satisfied with the proofs in support of his contention."

One of the British Mine Inspectors, in commenting on the lecture, anonymously, in *The Iron and Coal Trades' Review* says:

"There can be no doubt that there are coal-dust explosions, but they require a detonator in the shape of a shot or an explosion of firedamp to start them.

"When once started, it depends upon the dryness of the dust and the amount of air contained in the workings, for immediately an explosion commences, all the supply from the surface is cut off. There are many points needing further examination, such as the quantity of heat evolved and its action in keeping up the flame.

"In this way there may be an explosion in a non-fiery mine by the dust being ignited at a shot.

"I believe that in all the large explosions quoted by the lecturer coal-dust did perhaps nine-tenths of the damage. It follows that when an explosion happens in a *well-ventilated* colliery, the effect is more serious than in one that is badly ventilated, because there is more pure air for combustion.

"Of course, once establish the fact of a dust explosion, the question follows: Why do we allow explosives to be used in such mines? This is a very large question. The present idea is to have a flameless explosive, and there are parties who profess to have discovered such, but I have not seen them yet."

COAL IN ILLINOIS.

THE Report of the Mine Inspectors in the State of Illinois for 1894 has been received from the Bureau of Industrial Statistics of that state. It contains considerable matter of interest, and valuable tables of statistics.

Briefly summarized the Report shows the total output of all grades of coal for the year 1894 was 17,113,576 tons, a decrease as compared with the production of the year 1893 of 2,835,988 tons. The principal cause of this decrease was a strike. This strike produced the usual collateral consequences of all strikes; namely, a considerable increase in the percentages of fatal and nonfatal accidents. The fatal accidents show an increase of 26% over the average number of the previous twelve years, and the non-fatal accidents show an increase of 30% over the average. The Report ascribes the cause of the increase in the number of accidents to the excessively increased number of men employed and the very large percentage of inexperienced men. Naturally this has considerable to do with increasing the percentage of accidents, but another important factor that has been overlooked in the Report is the condition of the mines succeeding long periods of inactivity. During the times the mines are idle the pillars frequently disintegrate to a large extent and the supporting timbers are very much weakened. When the mine is in active operation these causes of danger are noticed before they have gone very far and measures are taken that check the destruction of the roof supports. When a mine is idle for several months the "stitch in time" is not taken and as a result the workings become more dangerous and remain so until a sufficient length of time has elapsed after the resumption of work to enable all the weak points to be detected and guarded against.

Several curious facts are disclosed by the report. For example, the number of machines in use for coal cutting during the year 1894 was 296, or 14 less than were in use in 1893. Coincident with the disuse of 4½% of the machines there has been a loss 13% in the yield of lump coal, and the reduced yield of lump coal occurs chiefly, but not exclusively in the machine mining districts. Machine mining requires a long face and the long face caused the greatest settlement of strata, and crushing of coal, during the period of the strike. When, on the resumption of work the machines were making a smaller yield of lump coal, the casual observer would imagine they were to blame and not the strike. Quoting from the Report on machine mining we have the following: "Machine mining is now virtually confined to the Fourth and Fifth Districts. Here is disclosed the loss and gain in the tonnage of lump coal for five years. This year's production shows a shrinkage of 2,247,615 tons compared with the year before. The Fourth District shows the largest decrease, the First District is next, the Fifth next, the Second next, the smallest being the Third." Here then we see that the falling off in production of lump is the second greatest in the First District, that is intermediate between the Fourth and Fifth, and that the falling off is neither due to hand or machine mining, but to some other cause such as we have mentioned. The number of accident due to falls of roof and sides is, according to all mining experience, here as elsewhere, above 60% of the total number.

The State makes a fairly good showing for the ventilation of mines as 37% of them are ventilated with fans, and including fans, furnaces and steam jets, 62% have artificial ventilation. It is probable that the other 38% are very small workings.

BOOK REVIEW.

MODERN EXAMINATIONS OF STEAM ENGINEERS.—By W. H. Wakeman. 12 mo. Cloth, 300 pages. Price $2.00. Published by the American Industrial Publishing Co., Bridgeport, Conn. This volume consists of a number of articles published originally in *The Manufacturers' Gazette* of Boston. They are compiled in 53 chapters, each chapter being the same as the article appearing in each issue of the periodical. The author has shown in the preparation of the work that he understands the technicalities of the subject on which he has written, but unfortunately he does not go into sufficient detail to make the book all he intended and claims it to be. It is a good work for practical engineers, firemen, etc., but there is a great deal of it that will be unintelligible to the average man whose early education was neglected. Taken as a whole, the book is well worth the price for which it is sold. Its only fault lies in its covering a wide range in too brief a manner, and in treating too briefly on some subjects which cannot be made clear to a man, unless he has a fair knowledge of elementary physics etc.

REPORT OF BUREAU OF LABOR STATISTICS, STATE OF ILLINOIS, 1894.—This report, compiled by Hon. Geo. A. Schilling, Secretary of the Bureau, contains, first an exhaustive report on taxation, with numerous official tables of statistics etc., to prove and exemplify the text, and an elaborate treatise on the evils of and remedies for abuses in the system of taxation. An appendix contains a statistical review of the coal miners' strike in 1894, together with a consideration of the results of the strike; the decision of the Supreme Court of Illinois on the "Sweat Shop Act;" Mrs. Potter Palmer's address at the opening of the Women's Building, World's Columbian Exposition, and Governor Altgeld's address to the graduates of the University of Illinois, on June 7, 1893.

ANNUAL REPORT OF THE SECRETARY OF MINES, PROVINCE OF VICTORIA, 1894. Price five shillings; published by Robt. S. Brain, Government Printer, Melbourne, Australia. This is one of the British "Blue Books," and as one of great value to the mine manager, or mine owner, is well as to the mining community in general. It contains (1) Special Reports, Descriptions of Machinery, etc.; (2) Operations of Diamond Drills in the Province; (3) Statistics. It is splendidly illustrated, and is worthy of rebinding in something better than the usual blue paper used by the British Government. It will be found of great interest to every mining engineer and mining student, not only for its present worth but as a book of reference for the future.

THE YARDLEY FAULT; AND THE CHALFONT ROCK, SO-CALLED.—By Benjamin Smith Lyman. This is an authors reprint from the Proceedings of the American Philosophical Society. The first is a description and discussion of a striking fault exposed at Yardley Station on the Bound Brook Div. of the P. & R. R., and the second describes and discusses the fault at Chalfont, Bucks county, Pa. Both papers are interesting reading for all interested in geology and the study of faults.

METALLURGICAL AND OTHER FEATURES OF JAPANESE SWORDS.—By the same author. This is a reprint from advance sheets of the *Journal of the Franklin Institute* for January 1896. Mr. Lyman, in this instance deviated from his general scientific papers, and prepared a lecture that was more of a popular nature, and exceedingly interesting to all classes. His long experience in Japan, in the practice of his profession, and his familiarity with Japanese customs and methods, together with his observing nature, specially fits him to describe the peculiarities of that wonderful nation in an intelligent and correct manner.

REPORT ON THE VICTORIAN COAL FIELDS.—By James Stirling, Asst. Govt. Geologist. This is one of the British Governments "Blue Books," and treats of the coal fields in the province of Victoria, Australia. It is illustrated by a colored geological map showing the tertiary, volcanic and mesozoic formations, and by a sheet of cross sections. The price of the work is 2 shillings. It is published by Robt. S. Brain, Govt. Printer, Melbourne, Australia.

YEAR BOOK OF THE SOCIETY OF ENGINEERS, UNIVERSITY OF MINNESOTA. This is an illustrated magazine consisting principally of treatises on engineering subjects, in which mining engineering is represented by two articles, one on Systems of Mining in Minnesota Iron Mines, by Chas. D. Wilkinson, and one descriptive of The Ore Testing Plant at the University of Minnesota.

ESSENTIAL PROPERTIES OF BUILDING STONES.—By H. Foster Bain, Asst. State Geologist, Iowa. This is a pamphlet or author's reprint from one of the State reports.

PERSONALS

Mr. Erskine Ramsey, Superintendent of the Pratt Mines Division of the Tennessee Coal Iron and Railroad Co., has been promoted to the office of Assistant General Manager and Chief Engineer of the company.

Mr. Ramsey has been succeeded as superintendent of the Pratt Mines Division by Mr. P. J. Rogers, warden of the Pratt Mines convict prisons.

Mr. Rogers will retain the post of warden in addition to his new office.

Mr. M. G. Moore, Mining Engineer of the Cambria Iron Co., Johnstown, Pa., called on friends in Scranton during the month. Mr. Moore is an old Scrantonian and is always a welcome visitor to his old home.

Mr. David J. Lloyd, of Pawnee, Ill., has broken the Illinois record in shaft sinking. Last spring he started an air shaft for the Chicago and Virden Coal Co., and completed it to a depth of 323 ft. in ninety days. In June he made a proposition to the people of Pawnee, Ill., that if they would advance him some capital, he would locate with them and sink a shaft for coal. His proposition was accepted. After making all his surface arrangements he started to sink on August 25th, and in 65 days cut Seam No. 6 of the Illinois coal measures at a depth of 315 ft. from the surface.

Mr. Wm. Griffith, Mining Engineer, of Scranton, Pa., is preparing a series of articles on Anthracite coal, for *The Bond Record* of New York. The articles will treat of the subject in a comprehensive and authoritative manner, and will contain much information for investors that will prove of great value. Mr. Griffith's experience, his opportunities to gather the necessary data, and his ability to make sound deductions therefrom, ensure the readers of that excellent financial journal, information that will be well worth reading.

The Columbia Calendar.

The Columbia Pad Calendar for 1896 has made its appearance, representing the eleventh annual issue, and handy and convenient as it has been heretofore, the new issue certainly surpasses any of its predecessors. The cycling fraternity, to say nothing of the general public, has acquired a decidedly friendly feeling for the Columbia Calendar, and its annual advent is looked forward to with interest and pleasure. The new Calendar contains a much better arrangement than in previous years, more space having been allowed for memoranda, while a greater charm has been added by liberal illustration and a unique and convenient grouping of dates calculated to meet the hurried needs of business men. The Calendar can be obtained for five 2-cent stamps by addressing the Calendar Department of the POPE MANUFACTURING COMPANY at Hartford, Conn.

Western Penna. Central Mining Institute.

At the annual meeting of the Western Penna. Central Mining Institute, held at Pittsburg, Pa., on the 26th and 27th ult. the election for officers resulted as follows: Inspector Thos. K. Adams was re-elected President; Mr. Daniel Boden of Carnegie, Vice-President; Messrs. William Seddon of Brownsville and J. C. Kyle of Imperial, Secretaries; Mr. Roger Hartley of Pittsburg, Treasurer; Messrs. August Schaner of Wilkinsburg, T. B. De Arnit of Turtle Creek and Roger Hartley of Pittsburg, Trustees.

THE CAPELL FAN.

Its Efficiency, High Water Gauge Obtained, and Durability at High Periphery Speed.

An interesting and important controversy was recently in progress in the columns of *The Colliery Guardian*, between Messrs Wm. Fairley and G. M. Capell, regarding claims made for the Capell fan. Mr. Fairley takes issue with the following statement published in our London contemporary on Nov. 8th:

"The patentee states that the new fan has been successfully introduced into the deep pits of Germany and Belgium working thin seams, and gauges as high as 11 in. and 12 in. have been obtained with it. Mr. Capell also informs us that the volumetric efficiency of the fan has been largely increased by the new form of construction."

We reproduce Mr. Fairley's criticism and Mr. Capell's answer *verbatim*, merely noting that Mr. Wm. Clifford, of Pittsburg, Pa., American manufacturer of the Capell fan states that "a guarantee of 200,000 cu. ft. at 12'' W. G. means that the fan will produce that volume if the mine will pass it at that water guage. In the cases mentioned by Mr. Capell, the quantities were passed at less than the guaranteed water guages."

To the Editor of the Colliery Guardian.

SIR:—At p. 889 of your last issue it is reported that the new type of fan has recently produced a water-guage of 12 in. It may be well to consider briefly what this amount of pressure represents. This force is equal to that generated by a body revolving at the constant speed of $\sqrt{\frac{12}{.000458}} = 161.86$ ft. per second; in other words, 12 in. of water-guage is the result of a fan running continuously at this tip speed, reckoning the machine to be perfect as regards the production of pressure. Fans, however are not perfect in this respect, and do not usually produce more than one-half of the theoretical pressure, but if it be assumed that this new type of machine has a manometrical efficiency of .8, it will be required to run at a speed equal to the theoretical pressure of $\frac{12}{.8} = 15$ in. water guage, and therefore would have to run at a velocity of $\sqrt{\frac{15}{.000458}} = 180.97$ ft. per second. Amongst the records of scores of observations of the work done by fans, no such speed is to be found, so far as the writer knows. Indeed, he considers himself justified in saying that there is no fan in England running at such a velocity, and that it would not be safe to run any of them at a higher tip-speed than 135 feet per second. Again, if the fan producing 12 in. of water-guage has a manometrical efficiency of only .5 (and many fans now running on English mines are giving less than this) it will be required to run at a tip-speed of about 229 ft. per second.—Yours, &c.,

Shafto House, Chester-le-Street, W. FAIRLEY.
11th November, 1895.

To the Editor of the Colliery Guardian.

SIR:—Your correspondent, Mr. W. Fairley, seems to doubt the possibility of running fans to give 11 in. and 12 in. water-guage, and suggests that 135 ft. per second is the limit of safety. I quite agree with him that this is so with ordinary fans not designed for high speeds. The fan at Pluto Colliery, Westphalia, I designed to give 210,000 cubic feet at 14.7 in. water-guage, calculations being made from a Guibal fan on the mine. I designed a fan, double inlet, 15 ft. x 6 ft. The result shows the fan was above its work:—

Revolutions	270
Water-guage	12.5 inches
Cubic feet per minute	240,000
Horse-power in the air	472
Periphery speed	213 ft. per second.

The first high-guage fan in Germany was at Prosper I. Colliery. I designed this (old style) 12.3 ft. x 6 ft. It gave us:—

Revolutions	323
Water-guage	10.7 inches
Cubic feet	127,000

Since that time I have had numbers of fans running at 8 in., 9 in. and 10 in. water-guage, without difficulty or danger, and all above 135 ft. per second. I have seen accounts of fans by a French maker, 8 ft. 4 in. diameter, giving 30 in. water-guage in steelworks, and running over 300ft. per second, with about 10,000 cubic feet per minute. There is no difficulty in meeting these speeds by proper construction, and I expect in the near future to have mine fans working under 400 mm., say 16 in., pressure. Experience shows it is far less costly to put up an economical engine and a high-pressure fan than to attempt to enlarge the airways in mines working far from the shafts. Facts are stronger than theory. There are the fans working and to be seen, and if theory does not like—why, so much the worse for the theory.

Another mine, General Blumenthal, also in Westphalia, has recently put down my 13 ft. 4 in. double fan. The guarantee was 200,000 cubic feet, at 12 in. water-gauge, and the result was:—

Cubic feet per minute	224,000
Water-guage	11.25 in.

The design of the fan in these high gauges is most important, and I need hardly say I have made a special study of it. The age of wooden blades and cast iron is over for fans. The Siemens-Martin steel has given a new power to all modern ventilators, and high speed is no longer the bugbear it was twenty-five years ago.

Yours, &c.,
Passenham, Stony Stratford, G. M. CAPELL.
November 20, 1895.

To the Editor of the Colliery Guardian.

SIR:—Mr. Capell has the writer's best thanks for his letter of the 20th inst., which appears on page 985 of your last issue. At the outset the writer had the belief that there are no such water-guages as 11 in. or 12 in. in England, because: first, such pressures are always associated with small equivalent orifices; and second, because it would not be safe to run the machines fast enough to generate this pressure; and as yet he cannot get far away from this opinion. So far as the writer knows, the equivalent orifices of the mines of England vary, say, from about 16 to 52 square feet—in rare cases there being some smaller and some larger. The highest water-guage on an English mine which the writer has noticed is recorded on page 223 of the *Transactions* of the North of England Institute of Engineers. In this case the reading was 5 in., the quantity of air 99,000 cubic feet, from which it will be seen that the equivalent orifice was 17.18 square feet, which for an English mine is comparatively small. The comparative smallness of the equivalent orifice is, according to the writer's observation, a characteristic of Continental mines, although in the examples referred to by Mr. Capell they have a comparatively good area. From the data supplied in Mr. Capell's letter, the equivalent orifices of the three cases cited work out to (1) 26.38 square feet for Pluto mine; (2) 15.06 for Prosper I. mine; and (3) 25.92 for General Blumenthal mine. The writer's intention, in his letter of the 11th inst., was to show the high velocity required for twelve inches of water-gauge, which is, in his opinion, unprecedented in English practice. The manometrical efficiency of the fan at Pluto works out to .60; that of the machine at Prosper I. to .53. If Mr. Capell's fan will stand working continuously at the high velocity required for a pressure equal to twelve inches of water, then he is to be congratulated on the success he has achieved.—Yours, &c.,

Shafto House, Chester-le-Street, W. FAIRLEY.
26th November, 1895.

THE CARE OF BOILERS.

Some Important Facts of Vital Importance to Boiler Users.

Through the courtesy of Mr. Albert H. Cary, engineering manager of the Abendroth & Root Co., of New York, we are enabled to give our readers some important facts regarding the use and care of boilers. These facts were brought out by expert testimony in a suit brought by the Phila. Edison Electric Co. against the Abendroth & Root Co., and a counter suit brought by the latter company against the former. It appears that the Abendroth & Root Co. sold the Phila. Co. some 3,500 H. P. of boilers, on four different contracts, each of which followed the other at short intervals. The first suit brought was to recover $34,000 from the Abendroth & Root Co., on the allegation of the Phila. Co. that a series of troubles and finally a fatal accident, were due to bad workmanship, bad material and faulty design in the boilers, and also due to the contractors failing to comply with all the articles agreed upon in their contract. The countersuit brought by the Abendroth & Root Co. was for $6,830.99 due on the contracts and for additional materials furnished.

The Abendroth & Root Co., succeeded in the first place in establishing the fact that they had lived up to every article of their agreement, and had even done more than they agreed to. They also proved that they had used the best material obtainable in the market.

The suit was tried before Judge Wheeler and a jury, in the U. S Court in Brooklyn and a verdict was rendered in favor of the Abendroth & Root Co., for the amount of the countersuit.

In this connection it is interesting to note that the greatest number of breaks occurring in these Edison boilers were reported to be in the item of bolts; and as it is a natural conclusion that the greatest breakage will occur at the weakest point, it was necessary to establish by evidence the fact that these bolts were equal, if not superior, to anything to be found in the market. When these bolts broke, in almost every instance a curious phenomenon occurred. At the point of fracture, the metal, instead of being contracted to a smaller area than that of the bolt itself retained the original size and area, showing no contraction whatever, but breaking sharply and squarely in a similar manner to a pipe-stem. This caused the question to be raised as to whether crystallization had occurred, and to determine this point, many of these bolts were taken to a steam hammer and flattened out cold to less than ¼ of an inch in thickness. In every instance the flattening was done without the slightest show of fracture running up into the body of the bolt, whereas if crystallization had taken place at the point of rupture the metal would necessarily show brittleness and breakage similar to the action of a piece of cast iron similarly treated. Another test applied to many of these bolts was to bend them double when cold so that the two ends met, and this also proved the excellence of the quality of the bolts. In order to show that no effort had been spared to improve the quality of the material used, other bolts made of the best rivet iron, were substituted in the place of the original ones, but all such bolts were fractured in identically the same manner, and a still further trial was made with steel bolts, which were affected with the same results. In order to make this breaking point test still stronger, ⅞'' bolts were substituted for the ¾'' bolts, but with no better results. Beyond this, the shape of the head, and also the shape of the lug which received the head of the bolts, were changed in every conceivable way, but all to no avail, as the fracture of bolts continued in this almost unaccountable manner, whereas fracture in the other parts of the boiler was very infrequent indeed. It follows that no better evidence could be furnished or was needed that good material was used throughout.

It was also proved that the workmanship on the boilers was first class, and that the workmanship and design of the boilers was not at fault was proven by the fact that similar boilers, made under exactly similar circumstances, used in other plants, had never acted in a manner similar to those in question, and it therefore followed that the trouble was due to local causes. It then became necessary for the manufacturers to prove what these conditions were, and this portion of the evidence is of interest to every power user.

It was proved that the accidents were due entirely to the unreasonable handling of boilers by the Phila. Co. It was shown that the boilers were frequently forced far beyond their rated capacity, and this rating was sometimes exceeded as much as 100% and over. It was also shown that unskilled labor was employed, and such employees had instructions to keep steam up to the required pressure, irrespective of any demands that might be made on the boilers, so as to keep the lights going which the Phila. Co. had contracted to supply.

One of the very important matters brought to light in this case, and acknowledged was the use of extremely bad feed-water. It seems that the Phila Co., sunk a well beneath their station, and this was the only water they used to supply their station. This water, as was shown by the analysis presented during the trial, contained not a small amount of sewage, and ran thirty-four grains of impurities to the U. S. gallon, almost eight per cent. of these impurities being proved to be sulphate of lime, while salt existed in appreciable quantities, and also a number of nitrates and ammoniacal salts. This water was what might be called the surface drainage of the City of Philadelphia, and as the city has unfortunately, a very poor sewage system, this drainage amounts to what might be regarded as sewer water which had undergone a certain amount of filtration in the earth down to the imprevious strata along which it ran and finally collected in this well. In order to counteract the bad effects from this water, no small amount of chemicals was used. These were changed at times, and finally the Phila. Co. seemed to settle down on the use of cutch, or what is more properly known in chemistry as Catechu, which contains a considerable quantity of tannic acid. In the storage tank located above the boilers large quantities of caustic soda were also put in the water, making so strong a solution that water dripping from it would take the hair off of the horses that passed beneath it, also inflicted serious burns upon the workmen who were so unfortunate as to catch a sprinkle. The result of the use of this bad feed water was naturally shown in the collection of a large amount of scale in the tubes, varying in thickness from $\frac{1}{16}$ of an inch to one inch, and thereby closing down very materially the area of the tube opening. The chemicals used attacked the metal parts of the boiler and oozed through the joints thus attacked so as to form incrustations, which had at times almost entirely covered the bolts and bends. The incrustation proved so hard that the workmen were obliged to use a hammer and chisel to remove it. This state of affairs caused a rigidity of parts which were designed to be flexible, and it also caused the unnecessary burning out of many of the tubes.

Another very important point established by the evidence was that an excessive forced draft was used in order to drive the boilers to the unreasonable extent to which they were used, and evidence showed that this draft was sufficient at times to support a column of water from three to four inches in height.

Several well-known experts appeared in this case and accounted for the various troubles above enumerated. One of the most interesting points developed was the production of water hammer in the tubes of these boilers, which was explained in the following manner: It is a well known fact that every pipe or tube has a definite capacity of discharge, and when this capacity is reached no more water or steam can be delivered through an opening of such an area; so that in case a larger discharge is required, a larger tube must be used. In driving these boilers to such an excessive extent, in the course of natural circulation the water and steam passed up along the inclined tubes to the front headers and there advanced upward into the overhead steam and water drums from which the steam was delivered to the piping system. When the circulation reached a point equal to the capacity of the tube, of course, no more steam or water could be discharged from that upper end of the tube, but as the heat still continued to be applied around the tube, more steam was generated, and of course the pressure of this steam in the tube forced the steam and water back down the tube until it reached the rear header and here the steam suddenly had a chance to escape upward by the course of the rear headers to the overhead steam and water drums, and the colder feed and circulating water trying to enter the lower end of the tubes from these same rear headers came in contact with the steam thus seeking passage of escape. The result was a sudden condensing of the steam which was followed by a rush of water into the vacuum at an exceedingly high velocity, and this water rushed along the tube at about this same velocity until it reached a bend at the end of the tubes. The result was a very sudden and powerful blow there, practically like that of a cannon ball, which caused the bolts to rupture in the manner above described, breaking them, in fact, so rapidly that a flow of the metal composing them at the point of rupture was impossible.

This flow necessarily would take a certain amoun time. The consequence of this sudden blow was exhibited in the breakage of these bolts without contraction of area at the point of rupture. It was remarked during the course of the trial that it was fortunate that these boilers were composed of small headers covered by small castings known as connecting bends, and that thus the damage done affected merely these small castings, producing the local results instead of rupturing large castings, which would, of course, be attended by far more serious ruptures. Glass models were shown at court which illustrated beautifully the theory thus presented, and in such a manner as to carry conviction to the minds of the Court that this was the true theory of the disastrous occurrences. Other glass models illustrated the irresistible power of the water hammer, the force of which was sufficient to break the tubes, which held the water surrounded by a vacuum.

THE PROGRESS IN MINING.

ABSTRACTS FROM THE PROCEEDINGS OF THE MINING SOCIETIES

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

Notes on Mining in Portugal.—In a paper recently read before the Mining Institute of Scotland, Mr. Robert Fisher said:

Very little has been done in Portugal in connection with coal mining, not because the country is destitute of coal, but largely on account of the protective policy of the Government, which imposes heavy duties all round, thereby crippling industry and discouraging enterprise. There is little doubt that a systematic and thorough exploration of Portugal would lead to the opening of coal and other mines, to the material benefit of its trade and commerce. There are three distinct coal deposits in Portugal. In the north, near Oporto, anthracite coal of good quality occurs, but it is often so mixed with shale as to render the working difficult. The principal mines are:—St. Pedro da Cora, Passal de Baioco, Covello, and Midors Pegus. The large coal extracted from these mines is used in Oporto in cooking ranges and stoves, and the small coal is made into briquettes for the same purpose. Near Busaco, at Santa Catherina, there are seams of a semi-bituminous coal, but they are not now being worked. Near the town of Batalha, which is situated sixty miles north of Lisbon and twelve miles south of the Oporto and Lisbon railway at Leiria, there is a coal-field extending to 1,200 acres, where the outcrops of several seams of coal have been located, and a few drifts made to prove them towards the dip. Two adit levels, about a mile apart, have been driven into the breast of a range of hills several hundred feet high. No. 1 mine, near Batalha, cross-cutting to the dip, has intersected four coal seams. The first seam lies at an inclination of 49 degs. towards the east, whilst the others are inclined at from 25 degs. to 30 degs. towards the west. The first coal seam, 6 in. in thickness, of good quality, and having hanging and foot walls of hard blue clay, does not appear to form one of a series of stratified beds overlain unconformably by the other beds, but strikes across the strata. Possibly it may be in the line of a dip fault. The other seams have the following sections:—

No. 1 coal seam.	Ft.	in.	No. 2 coal seam.	Ft.	in.	No. 3 coal seam.	Ft.	in.
Marl roof.			Shale roof.					
Coal	0	6	Coal	1	4	Coal	1	0
Shale	1	8	Marl	0	5	Shale	1	0
Coal	1	4	Coal	0	8	Coal	0	8
Shale	1	0	Clay	0	8	Fireclay pavement.		
Coal	0	8	Coal	0	2			
Fireclay pavement.			Fireclay pavement.					

The coal in these seams has the appearance of lignite rather than coal of the Carboniferous measures. The proportion of sulphur and ash is high, and altogether the coal is of little commercial value. Galleries have been driven for a short distance in these seams where the mines intersect them, and there are indications of improvement in thickness and quality towards the dip. No. 2 mine at Alcanada intersects No. 2 seam, into which a dook or dip drift has been driven for a distance of about 90 ft. Another adit mine is being driven at a lower level to intersect the three coal seams and clear the dook of water. In section, inclination and quality these seams are similar to those at Batalha. The small output of the Batalha mines was within the past year, sold at 1,000 reis per cubic metre when the rate of exchange was 5,660 reis per £1. The coal was riddled at the entrance to the mine and the dross carried in baskets on the heads of women to a hand-power washing-machine worked by a woman. Women were paid from 5d. to 6d. per day. The water was directed by means of a dam and mill-race, part of the latter being steep. At this point a woman shovelled the small coal into the current, which carried it into the machine; the washed dross was discharged over the mesh into a basket, which, when full, was emptied into the heap. The dirt was similarly treated; a small shutter fixed at the top of the shoot prevented it from getting out—until discharged when almost filled up to the level of the washed dross. In the vicinity of Porto de Moz, six miles south of Batalha, may be seen a coal seam 3 ft. thick, with sandstone roof and hard fireclay pavement, dipping 25 degs. to the north-east towards the mountain limestone range of hills, at the base of which the coal seam is exposed. Underlying it are beds of laminated blue shale with ironstone balls, limestone beds from 2 ft. to 10 ft. thick, as shown below:—

	Ft.	In.
Sandstone roof.		
Coal	3	0
Clay and ironstone balls	50	0
Limestone	6	0
Shale	7	0
Limestone	2	0
Clays		

The fossils found in connection with the limestone beds comprise corals, shells, and encrinites; but even with their aid it is difficult to determine whether these beds belong to oolitic or carboniferous measures.

The total imports of coal and coke into Portugal in 1892 and 1893, were as follows:—

	1892.		1893.	
	Tons.	Value (£).	Tons.	Value (£).
Coal	603,696	535,527	418,328	367,060
Coke	13,060	10,628	6,342	8,228

The decrease occurring in 1893 is attributable to the strikes in England, and consequent high prices asked for fuel during that time; and the increase in the manufacture of patent fuel in Portugal, partly from coaldust imported from England and partly from Portuguese coal. This fuel is taking the place of English coal to some extent at mills and other factories, and coal from the North of Spain is also being introduced.

Notes on the History of Coal Mining in Scotland.—These notes are copied from the journal of the British Society of Mining Students, and are the work of Mr. Walter H. Mungall, B. Sc.

At an early period in the history of the British coal trade the coal-fields of Scotland seem to have been known and to have received some attention, although there is little documentary evidence of the extent of the operations. Much of the early history of coal mining is associated with the history and deeds of the monks who occupied the various monasteries then established throughout the country, and some of their writings throw a little light on the infancy of the coal trade. Thus, among the earliest legal documents that have been preserved, in which there is reference to this industry, is a Deed of Conveyance from the Earl of Wfnton to the monks of Newtattle, of a piece of land in the neighborhood of Dalkeith, containing a stone quarry and a coal mine. This document, written about the year 1210, is significant of the fact that prior to that date coal mining operations had been carried on in the Lothian coal-field.

About the beginning of the seventeenth century fresh difficulties arose, and the fears that had been entertained half a century earlier seemed now to be almost realized. The supply of coal from parts that were easily accessible was now well nigh exhausted, and to maintain a supply equal to the demand that had arisen, it became necessary to work the coal that lay at greater depths. The new difficulties now to be encountered soon became apparent, and of these, not the least considerable was the difficulty of dealing with the water that was found in greater abundance than formerly. Where the situation of the mine and other local circumstances were favorable, this was overcome by driving level tunnels or adits from the lowest part of the workings across the strata till the surface was reached. Through these tunnels, or "Day Levels" as they were commonly called, the water flowed from the workings and discharged into some river or stream. In the case of mines less favored by local circumstances some mechanical appliance had to be resorted to for unwatering the mines. Probably the earliest form of mechanical contrivance for this purpose was the rag-and-chain pump, which consisted of a column of pipes through which an endless chain, with bunches of rags or other material attached at short distances apart, passed. These somewhat primitive pistons, ascending in the pipes, carried the water before them and it was discharged at the top. Motion was given to these water-raising machines by horses, wind-mills, or water-wheels where they could be applied. An improvement on this form of pump was the Egyptian wheel—a sort of dredger or bucket elevator. One of these wheels was erected by Sir George Bruce when re-opening his some-time abandoned colliery at Culross, near Dunfermline. Sir George, being a man of no mean ability, and having a knowledge of machinery "such like as no man has in these days," his colliery soon became renowned, not merely in the immediate neighborhood, but throughout the district. There were two shafts at the colliery, one on the shore and the other near low water mark, protected from incursions of the sea by an artificial embankment. His water-raising machine, consisting of thirty-six buckets, was placed at the pit on shore, and was actuated by three horses.

About the middle of the seventeenth century the collieries in the neighborhood of Culross were the most important in the district, and in 1663 "considering that several questions and debates do arise betwixt the buyers of Coal and the Customers and Receivers of the Bullion anent the measure of the Chalder" the measure then in use at these collieries was made the standard measure for coal.

The first pumps, apart from Egyptian wheels and earlier contrivances, that were introduced into the pits of Scotland were erected by the then Earl of Mar at his Alloa collieries.

A system of serfdom continued till, in 1775, parliament decreed that no person shall be bound to work in the mines, in any way different from common laborers, and under certain restrictions, liberated the collier from bondage after a given time, but his emancipation was not completed till the restrictions were removed by a further act in 1799. Females and children, however, still continued to find employment in the mines, and it was not till Lord Ashley's famous Bill became law, that the bearing system in Scotland was doomed to extinction, and the labor of young persons became regulated by statute. In carrying coals along the roadways and up the ladders in the shaft, the common load of a woman was from 200 to 240 pounds, while girls and small boys carried single blocks of coal, proportionate to their strength. The coals were carried in wicker creels or baskets fitted to the back and steadied with a strap across the forehead. In reporting on a colliery in Midlothian in 1830 where this system was then in operation the late Matthias Dunn says: "The bearers find their own lights and creels, and are hired at from 10d. to 14d. per day, by such of the hewers as are not fortunate enough to possess wife, sister, or daughter, the necessity of which tends to constant and early intermarriages amongst each other, and is attended with utter want of domestic comfort." To quote from a letter written in 1851 by Robert Brown, factor for the Duke of Hamilton: "Muscular strength in a female, not beauty, was the grand qualification by which she was estimated, and a strong young woman was sure of finding a husband readily. There is an old characteristic Scotch saying 'She's like the collier's daughter, better than she's bonnie,' proving the value put upon the description of female excellence."

The condition of the collier boy at the time of the passing of the Act of 1842 may best be described in the words of Wingate, the collier poet, who at the same time makes an appeal on his behalf.

> He's up at early mornin', howe'er the wind may blaw,
> Lang before the sun comes roun' to chase the stars awa';
> And 'mang a thousand dangers, unkent in sweet daylicht
> He'll toil until the stars again keek through the chilly nicht.
>
> See the poor wee callant 'neath the cauld, clear moon,
> His knees out through his troosers, and his taes out through his shoon;
> Wadin' through the freezin' snaw, thinkin' o'er again
> How happy every wean maun be that's no' a collier wean.
>
> Oh! ye that row in Fortune's lap, his waefu' story hear
> Aft sorrows no' sae deep as his ha'e won a pitying tear;
> And lichter wrangs than he endures your sympathy ha'e won
> Although he is a collier's, mind he's still a Briton's son.
>
> And ye wha mak' and mend our laws, tak pity on the bairn;
> Oh! bring him sooner frae the pit and gi'e him time to learn,
> Sae shall ye lift him frae the mire 'mang which he lang has lain
> And win a blessing frae the heart o' every collier's wean.

From this time onwards the social condition of the collier population has steadily continued to improve; their hours of labor have been shortened, their vocation has been rendered less dangerous, they receive good wages, and have many opportunities for self improvement which were unknown not many years ago. From being in a state of bondage at the beginning of the beginning of the century, the collier has risen to a state of liberty and independence not enjoyed by any other class of workmen. In many cases, especially in the east of Scotland, he occupies his own house, and in some of the thriving mining villages a large proportion of the houses belong to private individuals of the mining class.

Coal Mining at Hanover.—The following is copied from the *Colliery Guardian*:

The coal mining industry of Hanover dates back as far as the fourteenth century. With the exception of the mines in the coal measures of Piesberg, near Osnabruck, the operations are confined to the exploitation of the thin coal seams occurring in the Wealden formation at the north-eastern flanks of the Deister Hills, at the Suntel and at the Loccum Hills, near Rehburg. Notwithstanding the small number of seams and their thinness, the industry has attained considerable importance, and at the present time more than 4,000 miners are employed.

At the Deister mining is carried on partly by the Prussian government and partly by private capitalists. The government mine is the most important. It is worked exclusively by adits. The only workable seam dips 8 to 12 degrees, and has a maximum thickness of 16 to 25 inches. It has been worked for a length of six miles. At the present time there are four adits in use at different levels. The first or Kloster adit was driven in 1853, and encountered the seam at a distance of 4,750 ft. It is used for horse-haulage, the horses hauling twenty wagons, each holding a ton of coal. The output amounts to 200,000 tons annually or about 650 tons per shift. The work of the Kloster adit section is carried on by 1,240 men. The second, or Hohenbostel adit, was driven in 1834 in the north-western portion of the mine. At the present time 220 men are employed in this section, the output being 35,000 tons. At this adit there is a coal-screening and washing plant. The coal is run down an incline at the surface and conveyed by a tramway two miles in length to the loading station at Barsinghausen. The third or Egestorf adit in the south-eastern portion of the mine, has an output of 40,000 tons and employs 230 men. It is in connection with the Egestorf station. The fourth or King William adit is situated furthest to the east and affords access to a mine purchased from Baron Knigge. The daily output is 60 tons, which is used for local consumption; and 150 men are employed.

Besides these, there are numerous older adits which in some cases have to be kept open for draining the workings. A dislocated portion of the seam at the Kloster adit section is worked by a shaft in the Bullerbach Valley, which serves to raise the mineral 102 ft. to the adit, as well as to ventilate the workings. No mechanical ventilation is used, fire-damp fortunately not being met with. The seam is worked longwall, and the mineral is trammed in trucks holding 5 cwt. to the main haulage level, and thence, in the wagons mentioned above, to the surface. The seam is extremely variable in its character. It is rarely quite pure, the partings being frequently so thick as to render it questionable whether the seam is worth working. The sandstone roof is very firm, and consequently but little timbering is required. The amount of coal wrought per man per shift is calculated at 0.56 tons. Altogether 1,850 men are employed, and the annual production is 297,000 tons.

As the working by means of adits must naturally soon came to an end, the sinking of a deep shaft has been begun. The shaft which is 21 by 13 ft., has attained a depth of 400 ft.

The western neighbor of the Government mine is that of the Bantorf Coal Mining Company. Here 500 men are employed, and the annual production is 115,000 tons. From the Antonie winding shaft, levels are driven at a depth of 280 and 500 ft., the seam being worked by the longwall method. The output per miner is 0.75 ton per shift. East of this a small mine is worked by forty-eight men. It was formerly worked on a much larger scale, but the poor quality of the coal and the difficulty of disposing of the output, prevent its development. This is also the case with the Bredenbeck-Steinkrug Colliery, where coal is mined by seventy-five men for supplying Baron Knigge's limekilns.

The Government mines at Osterwald and Nesselberg are of greater importance. Some 220 miners are engaged, and the annual output amounts to 20,000 tons. Three seams are mined, averaging 18 in. to 2 feet. The main shaft is 300 ft. deep, and the longwall system of working is employed. The coal obtained is used chiefly in the sugarworks, glassworks, and brickworks of the vicinity. Near Munder, coal mining was formerly carried on on a large scale, but on account of the distance from the railway the works were abandoned at the beginning of this year.

There is an old colliery at Loccum Abbey, where a 9 in. seam has been worked since the beginning of the century. Notwithstanding the thinness of the seam, the coal realizes a good price, and with fifty miners employed, the leaseholder is able to carry on the work at a profit. The seam dips 3 to 8 degs. southwest.

The Obernkirchen Colliery is owned by the Prussian Government and by the Prince of Schaumburg-Lippe. The seam averages 13 in. in thickness. It is worked even where it is only 9 in. in thickness. The dip is 3 to

7 degs. northeast. The coal is very variable in its character ranging from gas coal to smithy coal. There are thirteen shafts serving for winding, ventilation and pumping, their depths varying from 200 to 600 ft. The longwall system is employed. The output per man per shift is 0·5 ton. The annual production is 240,000 tons, and 1,620 miners are employed. Special attention has to be paid to the ventilation, as large quantities of firedamp are met with. At the colliery there is a coal-washing plant, and a coke oven plant in which 35,000 tons of coal are coked annually yielding 20,000 tons of heavy and 5,000 tons of light coke. For coking there are thirty-two open Meiler ovens, the so-called Schaumburg ovens, in which the heavy coke is produced, and twenty-four closed Smet coke ovens, which yield as a specialty the Schaumburg coke, a very light, spongy, porous coke, much prized in the metallurgy of copper. The coke-works are connected with three of the shafts and with the Hanover-Minden main line by a branch railway of normal gauge.

Turning to the coal of Carboniferous age, we find that the old st seat of coal mining in the province of Hanover is the Piesberg, near Osnabruck. Originally belonging to the Cathedral, the colliery was transferred to the town in 1568, and in 1889 the civic authorities handed it over to the Georg-Marien Ironworks Company. The coal is an excellent anthracite, with a specific gravity of 1·6 to 1·7. There are four seams, with an aggregate thickness of 10 ft. Both pillar-and-stall and longwall methods of working are in use. Up to 1872 mining was carried on by means of adit levels. Now, however, the Stuve shaft in the northern portion of the anticlinal has been sunk to a depth of 700 ft., and the Hase shaft in the south to the depth of 200 ft. The Stuve shaft is equipped with two Woolf pumping engines at the surface and two tandem engines underground. The Hase shaft has an underground compound engine as well as one at the surface. The output, 600 tons daily, is brought to the surface by endless chain haulage along the Hase adit level. At the mouth of the adit there is a new coal-washing plant capable of treating seventy-five tons a day. In addition to the Piesberg anthracite mine, the company also own a small bituminous coal mine at Hilterberg. There are two seams, each 20 in. to 35 in. in thickness, separated by a parting of 5 ft., dip 60 to 70 degs. north. The seams are however, much dislocated by faults. The deepest workings are now 480 ft. below the surface. The coal is a very good gas coal, used exclusively in the gas-producers and in the brick-kilns at the Osnabruck steelworks. The colliery is connected with the Osnabruck-Brackwede Railway by an aerial wire ropeway.

In addition to bituminous coal, brown coal is largely mined in the province of Hanover. It is mostly referred to the lower Eocene period. At Delliehausen, in the Sollinger Forest, four seams occur of one to four yards thickness, associated with fireclay and quartz-sand, which is used for glass manufacture. The brown coal is wrought partly by mining and partly by quarrying; altogether 200 men are employed. The greater portion of the output is made into briquettes. In 1894 the mine produced 60,000 tons of brown coal, the amount of briquettes manufactured being 13,000 tons. At Duderode three seams of Miocene brown coal are worked. The top one is 5 to 8 yards thick, the second 2 ft. to 2 yards thick, and the bottom one 15 to 18 yards. While the material of the two upper seams is earthy and poor, the third contains a large proportion of lignite and bitumen. As brought from the mine, the brown coal contains 47 to 51 per cent. of moisture. The dry coal contains 48 per cent. of combustible gas. Safety lamps have consequently to be used in the workings. The output in 1894, with eighty miners employed, was 8,400 tons.

Atmospheric Pressure as Affecting Mine Explosions.—*Colliery Explosions and the Barometer.*—The members of the South Wales Colliery Officials' Association have been considering, at some of their recent meetings, the influences of meteorological changes upon colliery operations, and particularly the connection, if any, between fluctuations of atmospheric pressure and firedamp explosions. Opinion on the latter question, says the *Newcastle Chronicle*, has undergone many changes during the past few years. It was originally believed that escapes of gas were most likely to occur when the barometer had fallen suddenly to a low level. Experience has, however, shown that many colliery explosions, perhaps the majority, have occurred when the barometer is high, and conditions are what the meteorologists call anticyclonic. This has led some experts to the conclusion that fluctuations of atmospheric pressure have nothing to do with the causation of colliery explosions. But when we remember the important part which coal dust is now admitted to play in these disasters, that dust is most dangerous when dry, and that the air of an anticyclone is usually very dry, it is evident that dusty mines may be most dangerous in anticyclonic conditions, and the rise of the barometer to an abnormally high level may convey a useful warning. Yet anticyclonic airs are not invariably dry, nor, when they are, need they necessarily affect the atmosphere of a pit; for they may become more or less damp in the course of their journey to the workings. The question is not one upon which those who have studied it would care to dogmatize. But, on the whole, it seems probable that there is some connection between barometric variations and colliery explosions; that this connection is indirect rather than direct; and that it is due not so much to the hygrometric state of the atmosphere as to the production of earth tremors by the removal of weight from the earth's crust, or the reverse. The late Mr. R. A. Proctor, the astronomer, some years ago calculated the weight removed from or imposed upon a certain area of land during the rise or fall of the mercury by an inch. The figures were rather startling. Miners are well advised to study the bearings of meteorological changes upon their calling, but they would render the investigation of greater value if they were to make it include a systematic observation of the minor earthquakes which are constantly taking place. It may not be generally known that a movement is on foot to secure reliable records of British earth tremors by a band of volunteer observers, just as a similar band of observers furnish reliable data concerning the rainfall. The leader of the movement is Mr. Charles Davison, 373 Gillott Road, Birmingham. If those interested in the matter will communicate with him, he will, we are sure, gladly send copies of his hints for observing an earthquake.

Inflammable Gases in Quarries.—From the French *Annales des Mines*, we copy the following:

M. Oppermann, Ingenieur-en-Chef des Mines, has for several years noticed sudden disengagements of inflammable gas in the underground quarries of fire-clay at Bollene; but he states that this phenomenon, very rare and irregular, only occurs in the neighborhood of old workings, incompletely gobbed, while it always denotes the proximity of cavities in which the gas accumulates under pressure. When these cavities are broken into by driving, the gas escapes, and forms, with the air, a mixture which explodes in contact with flame, and often causes serious accidents. Similar facts have been described by M. Humbert in connection with the clay pits of Vanves and Malakoff, in the French department of the Seine, and also by M. Roberti-Lintermans in connection with the underground quarries of plastic clay in Belgium. The gases thus disengaged are hydro-carbons, among which *formene* or *methane* predominate. As regards the origin of these substances, it is observed that fire-clay does not contain organic matters, the decomposition of which can generate such gases, which, moreover, do not issue from great depths, as the compact clay mass is but little permeable. It is true that seams of lignite are found in the beds of white sand which separate the clay strata; but this lignite is too poor to disengage hydro-carbons. The fact that the gas always proceeds from old workings, in which there exist timber supports, had been noticed, and it was concluded that the gas is generated by decomposition of the wood. It has long been known that cellulose, which enters largely into the composition of wood, is susceptible of fermentation, and under the influence of *bacillus amylobacter* it decomposes, while giving off carbonic acid, formene and a residuum rich in carbon. As a rule, all vegetable matter left in contact with water undergoes a series of transformations which lead to the production of hydro-carbons. M. Leon and M. Leproux, ingenieurs des mines, have noticed, in many colliery of the Loire basin, disengagements of inflammable gas, caused by the fermentation of timber, which has remained under water for a long time, when the mines have been drowned, and this in collieries where the seams worked never give off fire-damp. M. Ledin recorded numerous similar cases which occurred in metalliferous mines, observing that if collieries have only been seriously troubled with fire-damp in recent times, this fact must be attributed to their development not being so ancient as that of salt and metalliferous mines.

Electricity in Mines.—The following is taken from the *Electrical Engineer*: The advantages inherent in the electric explosion of mining charges will be generally recognized. It permits of an absolutely simultaneous explosion of several charges, which is always desirable from the point of view of the destructive effect produced, and at the same time it avoids the loss of time brought about by consecutive discharges, particularly when they have to take place in badly-ventilated workings, from which the smoke and gases produced by the explosion can only be cleared out very slowly. Besides, there is no danger from miss-fires, and the workings can be immediately approached without fear of the delayed explosion, which is always a possibility with powder fuses. Moreover, there need be no danger from fire-damp, or from the act of firing the fuse. All these reasons, M. P. F. Chalon, writing in *L'Electricien* of October 5, thinks, will favor the use of electric fuses. Unfortunately, however, they are very expensive. In France, wire fuses cost 300 fr. a thousand, and the discharging apparatus comes to 400 fr. or 500 fr. High-tension or spark-dischargers are a little more economical, but it is not easy to determine previous to the explosion whether they are in perfect order, and it is necessary that the insulation of the conductors should be absolutely perfect. M. Chalon then goes on to describe a cheap American discharger, which he strongly recomends for adoption in fiery workings in French collieries. The discharger consists essentially of a magneto-electric machine driven by a rack and pinion, so that the action is very much like that of a garden hand-pump, an intermediate gear being provided to give the necessary speed. A discharger of sufficient size to produce twenty or thirty simultaneous explosions weighs 13 kilogs. (about 28 lb.), including the strong wooden case. It is designed to work with fulminate detonators up to a distance of about 500 yards. It is tested by connecting up to the terminals a small specially constructed incandescent lamp. A separate apparatus is required to test the fuses and line. A current is sent through the line, not strong enough to heat the wires of the fuses, but sufficient to ring an electric bell if the circuit is in good order and complete. An arrangement is provided for adjusting the current to the number of fuses in circuit.

Wanted.

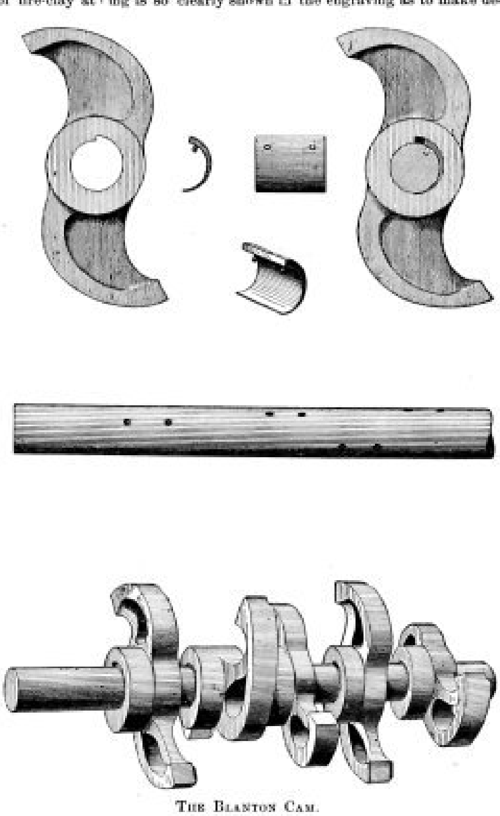
A practical and experienced mine foreman of strictly temperate habits. Address 421,
Care COLLIERY ENGINEER Co.

The Blanton Cam for Stamp Mills.

A device recently introduced by Frazer & Chalmers of Chicago, by which the changing of cams on stamp mills is greatly facilitated is illustrated in the accompanying engravings.

The difficulty of removing worn out cams from shafts when the cams have been secured in the ordinary way is too well known to mill men to be dilated on here, and it was to avoid this trouble that the cam and fastening herewith illustrated, known from its inventor, as the Blanton, was devised.

The construction and operation of this cam and fastening is so clearly shown in the engraving as to make de-



THE BLANTON CAM.

tailed description superfluous. It is the work of but a few minutes to remove or renew any cam and such can be easily done without taking the shaft to a machine shop.

The expense of refitting mills with these stamps is comparatively slight. A slight "backing" of the cam on the eccentric-shaped wedge and the cam is easily removed. Messrs. Frazer & Chalmers have had a large demand for these cams both on new stamp mills and for refitting old ones, and their use bids fair to become general.

Cableways on Chicago Drainage Canal.

The Chicago Main Drainage Canal is to-day probably the most interesting engineering work being carried on in the world, and is an interesting exposition for contractors machinery. The visitor to this canal is at once impressed by the great number of travelling cableways. As built by the Lidgerwood Manufacturing Co. of New York, they are to be found on nearly all the rock sections on the canal. On section two, McArthur Bros. use two cableways; on section three, the Des Plaines Cons. Co. use four; on section four, McArthur Bros. use two; on section five, the Qualley Cons. Co. use two; on section six, Mason, Locher & Williamson use four; on section seven, Locher, Harder & Williamson one; on section eight, Mason and King three and Locher, Harder & Williamson two. The only reason why about ten more cableways were not installed on this work was because the travelling cableway was not perfected in time. It is a fact that cannot be controverted however, that since the travelling cableway demonstrated its present capacity no other hoisting and conveying machine was sold on the canal. One cableway was used on the river diversion work, and is now no longer used, however the balance, nineteen can be seen in daily operation, in fact working night and day. The travelling cableway is capable of handling 600 cubic yards of rock in place per day of ten hours, and any capacity short of that is due to the difficulty of loading the skips.

A Creditable Publication.

The "Record Almanac" issued by *The Wilkes-Barre* (Penna.) *Record* is one of the most complete annuals we have ever seen. It is a complete encyclopedia of Luzerne County's history, politics, societies, sports, etc., etc., for the year 1895. Its mining statistics are very completely, yet concisely stated. It reflects great credit on Messrs. Johnson & Powell, the publishers.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

Recapitulation of the Principles of Action of the Centrifugal Fan.—The Varying Density of Air.—To Find the Volume of Air Entering a Fan.—The Balance of Mine Resistance.—One Ventilating Machine for One Stream—Advancing Curvatures of Blades.

98. Recapitulation of the Principles of Action of the Centrifugal Fan.—It is important that we should review the conclusions we have arrived at concerning the mode of action of the centrifugal fan, for this enables us to introduce such illustrations as will manifest to the eye and the mind of the reader that the deductions of our previous lessons were based on invariable law. For example, in the lesson given in the last October issue, it was shown that a stream of air in common with that of other fluids is never set in motion by tension, but by compression and therefore the direction of the stream is always into a region of depression. Now the statement just made is capable of the most satisfactory manifestation; and in support of this conclusion we introduce Fig. 135, and here it is seen that water is in the course of being upraised or really pumped by centrifugal force. The mode of construction and and the principle of action of the apparatus shown by the figure is as follows: A hollow horizontal shaft at S, is connected by a handle H, for rotating the arrangement, and between the supports a tube branching from the hollow shaft extends to C; the object of this branch pipe is to generate by its rotation the required centrifugal force, and when this pipe rotates radial fashion in a vertical plane it is the exact analogue of the blade of the fan. The hollow shaft S is connected with the fixed upright pipe or tail column PP by a gland G, to make a water tight joint and allow for the rotation of S. At the bottom of the "stand pipe" PP, a faucet is shown just over the surface of the water in the tank V. To start this centrifugal pump, the radial pipe C is set in a vertical position with its open end upward and the trap valve or faucet is closed, when water is poured into C until the radial tube, the hollow shaft and the stand pipe are filled, then the faucet is opened, and at the same instant the radial pipe is rotated by the handle H. At this same time water will be discharged out of the open end as seen at C, and will thus continue the outflow until the tank V is emptied. Now arises the all important question: how does the water rise in the stand pipe PP to a considerable elevation above the surface level of the feed water in V? the answer is clear and conclusive because fluids cannot be moved by tension like solids, but by compression; and this being so, it follows that there must be a depression in the region of the junction of the radial tub C, with the hollow shaft S, for otherwise the water could not rise from the water level in V, up the stand pipe PP to the elevation of the hollow shaft S.

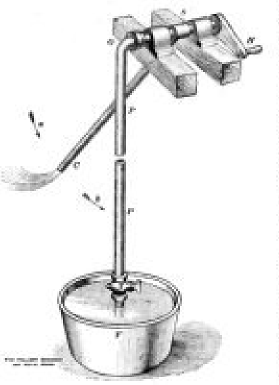


FIG. 135.

To understand the matter clearly, let us assume some values to reason with. First, then, let the pressure of the atmosphere be taken at a column of 34 feet of water. Second, let the elevation of S above the water level in V, be equal to 16 feet; and third, let the resistance due to the flow be equal to 5 feet of head, then $16 + 5 = 21$ the amount of the difference in pressure required between that of the atmosphere and that at the junction of C with S. For the depression at the junction must be $34 - 21 = 13$ feet, or if the pressure of the atmosphere is equal to that of a vertical column of water 34 feet high, the pressure at the junction cannot be more than that due to a vertical column 13 feet high, consequently we here establish the conclusion previously arrived at, that air cannot enter a fan until a depression or a reduction of pressure has taken place in the air between the fan blades in the region of the orifice of entry. In addition we learn that the velocities of fans must vary for the same quantity, as the square roots of the heights or resistances, and that the same fan can be made to pump different quantities or volumes of air with the same water gauge when the mine resistances per unit volume are different. For example, with a depression of 21 feet of water column we obtain say, a discharge of water out of our tube C, of 20 gallons per minute at an elevation say, of 21 feet, but at an elevation of 7 feet and with a depression still of 21 feet we would obtain $\sqrt{\frac{21}{7}} = \sqrt{3} =$ 1.732 or $1.732 \times 20 = 34.64$. Now if we obtain different quantities with the same motive pressure, we can by the figure before us discover the cause of the apparent anomaly.

There is another matter of first importance that claims our attention while this figure is under notice, and that is, the velocities of fluids into depressions, and here let us make it quite clear that fluids, apart from gravitation and inertia, are only moved by a superior pressure into a depression. We may then after having realized this truth practically, apply it in a few examples that will now engage our attention; as for example: Air is found to be blowing into a depression, where the pressure is two pounds per square foot below the pressure of the atmosphere, what then is the velocity of the wind? By the well known law, the velocities of air currents vary as the square roots of the pressures, or the converse, the pressures setting air currents in motion vary as the squares of the velocities. Now if we know the square of the velocity of air into a vacuum, and the pressure per square foot of the atmosphere. The atmospheric pressure would be to any other pressure, as the square of the velocity of air into a vacuum is to the square of the velocity of the air sought for by the proportion. Now the square of the velocity of air into a vacuum is 1,800,000, in feet per second and the pressure of the atmosphere is 2,120 pounds on the square foot, then 2,120 : 2 :: 1,800,000 to 1,698 +, that is to say the velocity of an air current subject to a pressure of two pounds per square foot, if the density of the air moved was the same as that of the normal atmosphere, would be $\sqrt{1{,}698} =$ 41.2 feet per second, and should the density be half that of the normal atmosphere, then the square of the velocity would be 3,499, or the velocity would be 58 feet per second. It will be seen that the mass of air at 58 feet per second and at half the normal density, is much less than the mass at 41.2 feet per second, and of full density as $\frac{58}{2} \div 41.2 = .7$ or as 1 is to .7; and it is for this reason that $2{,}130 + M^2$ was taken as the denominator of the fraction in the formula given in a former lesson; and while we are engaged in this inquiry, let us introduce an example of the use of the formula we have referred to. Then let T be the pressure calculated from the fan blades at a given velocity, and let M be the mine resistance, and let the case be that of an exhaust fan, then $\frac{(T - M) \times 1{,}800{,}000}{(2130 + M^2)}$ is equal to the square of the velocity of the air into or out of the fan, for let T equal 13 pounds, and let M the mine resistance in pounds per square foot equal 10 pounds, then $\frac{(13 - 10) \times 1{,}800{,}000}{(2130 + 10^2)} = 2421.52$. The velocity then is $\sqrt{2421.52} = 49.2$ feet per second. As a further illustration of the facts just cited Fig. 136 is given.

99. The Varying Density of Air.—To furnish a graphic idea of the different densities of the air within a fan, let M and M on the opposite blades represent the density of the air on entering the fan, which would be according to Boyle's law and the M just given $\frac{(2120 - 10)}{2120} = .9952$. At D and D the point of maximum depression is reached, and at A and A, the normal pressure of the atmosphere is attained, and at P and P the pressure of discharge is attained, or $2130 + T - M = 2130 + 3$, and the density therefore is $\frac{(2130 + 3)}{2130} = 1.0014$, or we may state the case as follows:

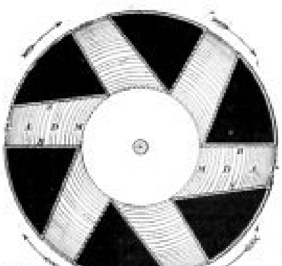


FIG. 136.

Density of the in flowing air .9952.

Density of the air at discharge 1.0014.

100. To Find the Volume of Air Entering a Fan.—In the case just noticed it will be seen that the velocity of the air entering a fan is greater than it is on leaving a fan, because the mass of air entering a fan, is never more or less, than the mass leaving it, and it follows that the velocity will be inversely as the density; hence the velocity on entering the fan will be in the proportion of 1.0014 and the velocity on leaving the fan will be in the proportion of .9952. And the mass per cubic foot entering the fan may be proportionate to 1 and that leaving the fan will therefore be 1.00623 or

Mass entering the fan $1 \times 1.0014 = 1.0014$.
Mass leaving the fan $1.00623 \times .9952 = 1.0014$.

It will be remembered that we referred to the *vena contracta*, and said that before it could be taken say at .62 due allowance must be made for any obstructions that would constrict the ports either at entrance or discharge, and we have introduced fig. 137, to draw attention again to these important matters.

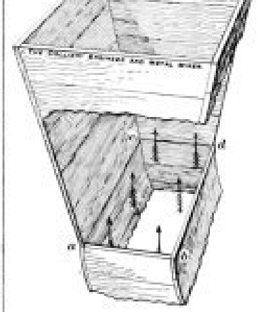


FIG. 137.

Calculations for velocities and quantities must always be made for the smallest orifice, whether it be located near the entrance or discharge of the fan. In this case the rectangular orifice a, b, c, d is supposed to have the smallest area, and is therefore taken, and to ward off any misunderstanding about how the quantities are calculated let us suppose the velocity is 41 feet per second and that the orifice gives a clear section of $6 \times 8 = 48$ square feet and taking the *vena contracta* at .62 the quantity passing through this orifice in cubic feet per minute, must be $48 \times .62 \times 41 \times 60 =$ 73209.6. The true measure of what a fan does is clearly indicated then by the processes given at first and now repeated.

101. The Balance of Mine Resistance.—We have great pleasure in introducing Fig. 138, because it makes quite clear and satisfactory a matter that was calculated to excite surprise and even doubt about the accuracy of the conclusion arrived at in a former lesson, when we stated that two, ten, or a hundred, or any number of fans would all have to run at nearly the same speed as one fan to exhaust the same quantity of air and no more than that obtained with the single fan; and in support of this conclusion the figure furnishes unmistakable evidence. Before water can be raised by centrifugal force out of the tank T, four centrifugal pumps in this case A, B, C and D must each and all run at a speed the same as that of a single pump to produce a depression into which the atmospheric pressure on the surface of the water at W can lift the column into the depression made. Now this depression can only be made in one or any number of fans by a fixed amount of exhaustion that is due to an equivalent amount of centrifugal force, and this force is due to a velocity that cannot be substituted by a lesser one, for if the column from W to A or B, or C, or D is equal to 21 feet, then for the water to rise to that elevation, they must all make the same amount of depression; that is, they must all lower the atmospheric equivalent from 34 to 13 feet; or let us suppose that A has made a depression of 21 feet of head or a depression to 13 feet of pressure, then the centrifugal pumps B, C and D, would receive no water from the rising main, or they would be useless until they were run at the same velocity as A. Here then we see that an increased number of fans would reduce very little the peripheral velocity of any

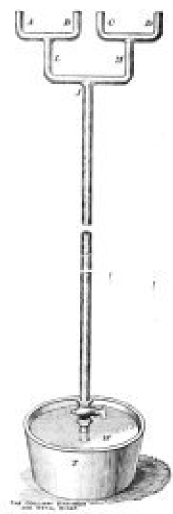


FIG. 138.

number of fans while the resistance remained the same as that due to one fan.

102. One Ventilating Machine, for One Stream.—The figure under consideration teaches another great lesson; namely, that there should only be one fan, for one ventilating current, or there should never be more than one fan exhausting out of the same drift, for if there is more than one set to exhaust the same stream of air, they introduce a high resistance that arises from an unpreventable cause, and let us try to discover its nature and character. In the first place let us notice that it is impossible to set up two fans exactly alike and under the same conditions of approach and discharge; and it is still more impossible to erect two steam engines with their valves so made and arranged, that the clearance, and the cut off, and the release will be identical in the two cases, but as we assume that each fan is worked separately with its distinctive engine, we cannot, so run the engines as to sychronize their movements so that the beginnings and endings of the strokes shall be coincident; the result is, we would find a high resistance, arising from an intermittent action developed by two causes, first, the instability of mechanical equilibrium; and second, the variations in the power due to the varying tangential force on the crank pins of the respective engines. It is singular and yet true, that in mechanics, we can only get uniform time out of varying velocities, and this is even true of the clock, for the pendulum or the spring, only regulate the escapement by acceleration and retardation.

In celestial mechanics the orbits of all the planets are elliptical, and the result is the body accelerates in going into perihelion, and retards in going to aphelion, and it is so with the comets and all other wanderers in space, the winds that blow are intermittent, the noise of water escaping from a faucet is the result of intermittent motion along the line of equilibrium, and how much more will this occur with two or more fans? Let us suppose that the pump *A* for a moment accelerates, then at that moment it will make a greater depression than *B* and will cause the inert water to run in its direction, but when *A* gets more water it will do more work, and if *A* gets more work, it will run at a less velocity, and while *B* gets less work, it will run at a higher velocity, and at that moment it will make a greater depression, and the result will be the water will leave *A* and run to *B*, and so on with the others in succession. We can, therefore, see that two or more fans running together will provide work for themselves, by developing an increased resistance out of the action and reaction due to intermittent motion.

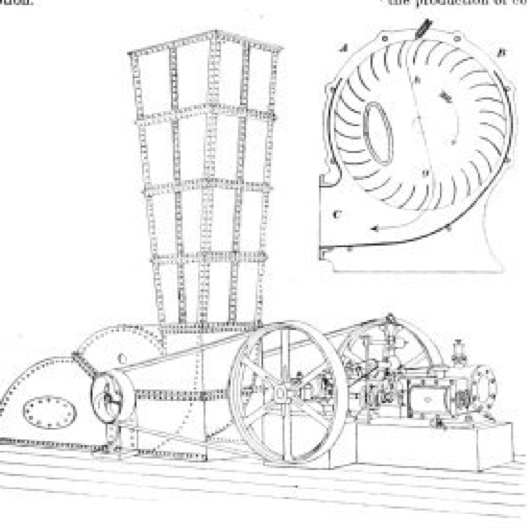


Fig. 139.

103. Advancing Curvatures of Blades.—Fig. 139 is an illustration of what is called the "Mortier Diametral Fan" and we only introduce it here to recapitulate what was shown in reference to the retreating curvature of fan blades, for this fan fully sustains all our conclusions, as it will be seen that the curvature is the reverse of retreating and is actually advancing as shown by the arrow on the *B* side of the long arrow *g*, *h*. This fan does not take in air at a concentric central orifice but strange to say it takes in air through one segment of the periphery as from *A* to *B*, and discharges it through another segment that is open into the evasey chimney as at *C*. The makers of this fan claim that its principle of action is independent of centrifugal force, and we are sorry to say that we think they are mistaken because the particles thrown off the revolving blades as by *g* are not only subject to centrifugal force, but that in a multiplied degree. They claim that the course of the particles passing through the fan is along the trajectory *h*, *g*, or the arrow *h*, *g*. These conclusions may be right or wrong but with that we decline to treat, for our present purpose is to show that if straight radial blades were a cause of loss of mechanical efficiency, how much greater should be the loss due to blades having an advancing curvature, and yet along the lines of what we claim and teach they get, as we expect, good results without unusual resistance.

This fan finally sets aside the claims of the retreating curvatures of fan blades, and sustains the conclusions we have arrived at in the former lesson.

This fan is made to intake air by scooping it in, and taking advantage of its inertia, and this is done on the *A B* side. The inflowing stream enters at an angle of 20 degrees with the mean tangent of the segment, and the air is undoubtedly discharged by a centrifugal force that is increased by acceleration along the blades that are curved in advance. In our next lesson will be introduced a number of examples worked out to elucidate the principles of the action of the centrifugal fan.

(To be continued.)

MINING METHODS.

Air Coursing in Relation to Haulage.—How the Cars Produce Coal Dust.

79. Air Coursing in Relation to Haulage.—It is now a decided principle in coal mining that haulage should not be carried on in the return airways, and therefore, mines are planned and the roads are made in conformity with this rule.

Haulage in a return airway introduces a greatly magnified danger, because the air on these roads is always charged in a greater or lesser degree with fine coal dust in suspension and marsh gas, and observation and experience, and well attested experiments have established the fact, that air charged with these very inflammable substances is always either in a dangerous condition, or in a state of partial saturation.

The presence of these two combustible bodies in the air of such a haulage road is due to two causes, and one of them is normal, or it is peculiar to it; for the object of ventilation is to gather up and carry off in the return air the gas produced by the coal, or that given off from fissures either in the working places or in the roof, sides or floor of the roads, or the broken cover or underlying rocks of the gobs. The other dangerous body in the return air is not only not normal, but arbitrary, and it is therefore dispensable, or in other words it is a self imposed danger.

80. How the Cars Produce Coal Dust.—No practical miner can fail to notice that fast running cars produce more coal dust than slow moving ones, and granting that this is true, we at once realize a great fact, namely, that fast running should not take place in a return airway. It is true that we cannot in level seams, or those of small pitch, avoid hauling cars from the working face in return air, because the fresh air of the last room, is the return air of a former one, but this is not in any sense a main haulage, but a local one where the cars are hauled singly at a low rate of speed. The question now arises: How does the rate of speed affect the production of coal dust? and the answer is decisive, for the dust scattered on a given length of the road is inversely as the time, or directly as the speed; that is to say, if the speed of a train of cars is doubled, the volume of fine coal delivered into the air will be doubled, and we might conclude that this statement had about it the "air" of a finality, but this is not so, for the writer knew a case where an explosion occurred during the running in of an empty train, on which rode a man carrying a flaming torch light.

Now, in a case like this we can only arrive at one conclusion, and that is that the inflammable contents of the air were raised by the whisk of the train of cars running in a confined gallery of relatively small area, or that the dormant dust had been lifted by the rapidly whirling wind eddies developed at the front and rear and along the sides of train, and as we have seen in such a case, the bright air becomes densely clouded with easily suspended flocculent particles, that contain so little matter, that the shell of air that envelops them contains sufficient oxygen for their combustion.

We see, then, that the saturation of the air with coal dust arises from two mechanical and correlated agencies; first, the dust arising from the loaded cars, and second, the dust raised with the whisk of the train; and the conjoint effect of these two causes is startling in its magnitude, for the amount of the saturation of air with flocculent dust varies as the squares plus the velocities of the cars. As we have just stated, the prime source of the dust varies directly as the velocities of the cars, and this we can discover by noticing that the shaking effect set up by the rocking and vibrating of the cars varies as the squares of the haulage velocities, and at first sight this fact presents the phase of a contradiction, but on further investigation it is found that, though the volume of dust given off per second is quadrupled when the velocity is doubled, the time of running the course is inversely as the velocity, or the train runs the journey in half the time, and, therefore, the volume of dust scattered in the air and on the floor and sides of the airway per journey is directly as the velocities, because $\frac{v^2}{v} = v$. We have just referred to dust brought in and scattered in the airway, but the greatest source of danger arises from the dust that is raised by the whisk of the fast running train, because the power of the wind to sweep up and raise the dust varies as the squares of the velocities, and, therefore, the sum of the causes of floating dust due to a train of loaded cars is equal to $v_1^2 + v_2$. Observe, then, that the dust in the air due to a loaded train varies as $v_1^2 + v_2$, and the dust due to an empty train varies as v^2.

With the facts just cited before us, we learn now that the running of cars in mines should be as little practiced as possible in the return airways, and further, the upraised dust is more to be dreaded than the dust given off by the coals in the cars, and, therefore, it is important that the roads from the working face to the main haulage should be kept as free from dust as possible.

To correctly establish our meaning concerning the haulage on dusty roads and especially on return roads connecting the rooms in flat workings with the main roads, we introduce Fig. 121. It will be seen at a glance

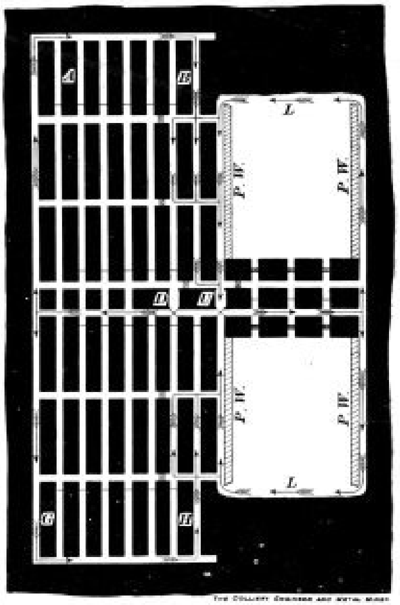


Fig. 121.

by a practical miner that the ventilation and local haulage are both bad and it often occurs that more attention is given to the development of a novel system of working than to the collateral particulars that may affect the mode of obtaining the coal favorably or unfavorably.

In this case we introduce a novel system of *part longwall* in which gob packs are made if sufficient top rock falls for that purpose and side pack walls are built as *P W*, *P W* on the right hand side of the figure. The object of these two pack walls should be to do duty as brattice. On the left side of the longwall gob are two pack walls also *P W* and *P W*; their intended use is to so break the cover as to prevent it breaking over the first line of pillars. Now this "part longwall" is often convenient and successful where top rock is not available for making roads through the gob, and therefore the roads are

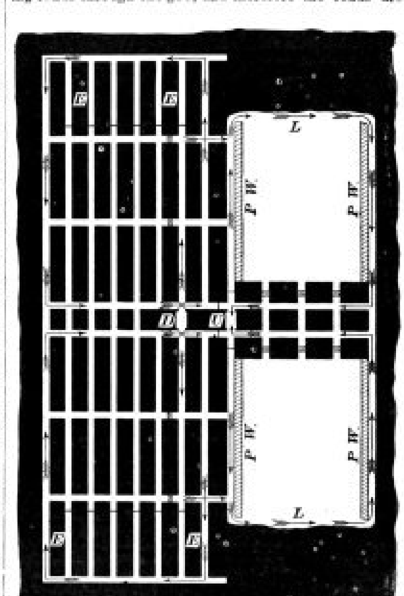


Fig. 122.

made secure with pillar walls and are used for ventilation and haulage, but here the haulage is done in return air when it could be otherwise, and therefore the only excuse possible in a case like this is to suppose that the pitch of the seam is across the map from the pillar to the longwall workings or from *A* to *B* or from *G* to *H*. In that case the ventilation of the longwall face at *L* or *L*, would be the best possible for the removal of the gas from the face and the gob, but before this longwall with coal gates or roads was commenced the forewinning of the district should have been done by advancing the pillar roads down the pitch, or by commencing the longwall workings on the west instead of the east side of the pillar roads,assuming for the sake of explanation that the top of the map is north.

Where the seam is quite level, however, the "part longwall" can be worked and ventilated on correct principles as illustrated by Fig 122. *E E* at the top of the map and *E E* at the bottom indicate that the seam is not pitching.

The cars now run in fresh air and besides, the main haulage roads are directly in line with the hoisting shaft. The advantages of the last plan are so evident that no arguments further than those that come from practical experience are required and yet when the two illustrations are set side by side, we can see how mistakes can be made, and further we can see the importance of considering how we should ventilate as well as work a field of coal before we put any plan into practical effect.

(TO BE CONTINUED.)

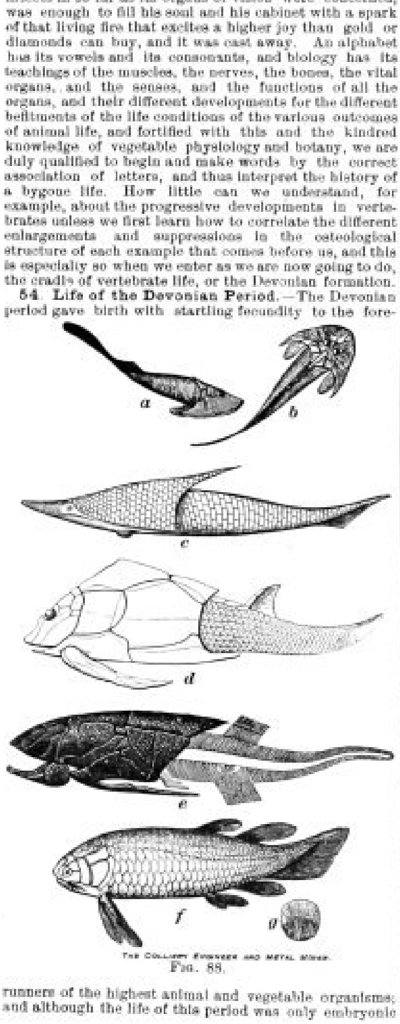
GEOLOGY OF COAL.

The Alphabet of Life.—Life of the Devonian Period.

53. **The Alphabet of Life.**—No man can ever succeed in making the study of the science of geology pleasing to his own feelings, and useful in his profession, unless he first studies and learns the first principles of the science of biology. You might with as much propriety call a maker of jingling purposeless rhymes a poet, as call a man a geologist who has collected fossils to fill a cabinet, and knows nothing more about them than the greek names he has written on their labels. The science of biology furnishes the alphabet out of which we are able to spell the words that reveal the environment of the life of every organism, animal and vegetable, that once lived and is now only represented by its fossil cast in stone. As a proof that the study of geology requires a qualifying fitness from a knowledge of biology, the writer remembers a case where a collector of fossils showed him some examples of trilobites, and pushing one of them to a side as he considered it worthless, he remarked, "you may have that one if you choose, as I have plenty better ones." Now, the castaway specimen was worth many times more than all he had, because it was stamped with the insignia of its rank among sentient beings, and this was no less than a perfect print of the facets of its compound eyes.

Why! To be able to associate this crustacean with insects in so far as its organs of vision were concerned, was enough to fill his soul and his cabinet with a spark of that living fire that excites a higher joy than gold or diamonds can buy, and it was cast away. An alphabet has its vowels and its consonants, and biology has its teachings of the muscles, the nerves, the bones, the vital organs, and the senses, and the functions of all the organs, and their different developments for the different befitments of the life conditions of the various outcomes of animal life, and fortified with this and the kindred knowledge of vegetable physiology and botany, we are duly qualified to begin and make words by the correct association of letters, and thus interpret the history of a bygone life. How little can we understand, for example, about the progressive developments in vertebrates unless we first learn how to correlate the different enlargements and suppressions in the osteological structure of each example that comes before us, and this is especially so when we enter as we are now going to do, the cradle of vertebrate life, or the Devonian formation.

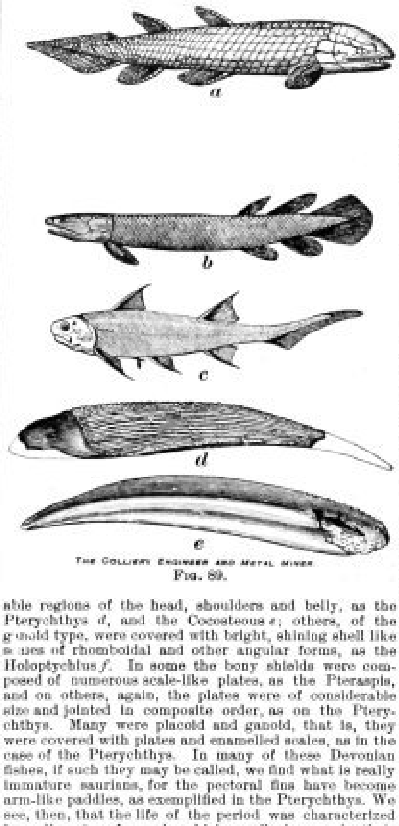
54. **Life of the Devonian Period.**—The Devonian period gave birth with startling fecundity to the fore-



THE COLLIERY ENGINEER AND METAL MINER.
FIG. 88.

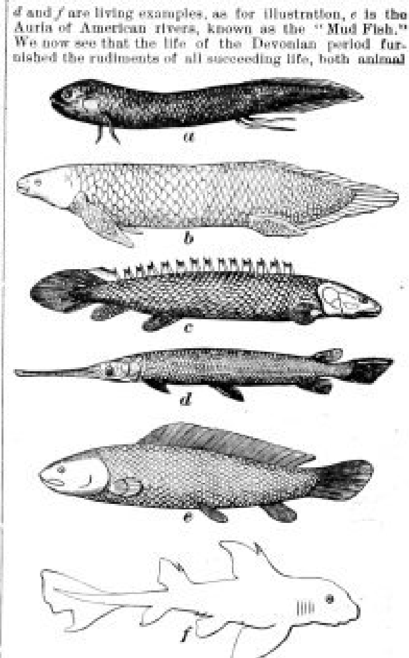
runners of the highest animal and vegetable organisms; and although the life of this period was only embryonic in the two kingdoms, it was remarkably coincident with a greater fitness for life on land and in the sea, for now great land masses had emerged and still left large areas under very shallow waters wherein immature saurians found a congenial environment. The struggle for existence must have been fierce and severe among creatures whose organs of locomotion were rudimentary and ill adapted for offense, and therefore their organs for defence were of a very formidable character, and the result was many of the fishes of the period that were slow swimmers and otherwise inert, were protected, as seen in Fig. 88, with plates of armor and shields to protect them from the assaults of their predaceous enemies. This was the age of ganoid and placoid fishes that swarmed in these early seas, and out of their differentiating cartilages have come the rudiments of the organs of the latest and highest life forms that now sport in the seas. It was the age that matured the vertebral column, and the peculiar organs of locomotion, the pectoral and ventral fins, or paddles of propulsion that were extended by processes hinged on to the vertebral column of these primitive fishes. In nothing is the unity of structural relationship so manifest as in the skeleton of an animal; for if it is viewed apart from all types it is found to be homologous, and the only differences found all along the differentiating line of vertebral organisms, are in the extensions and suppressions of individual bones. Truly then we may claim that the Devonian period was the cradle of the higher life now on the earth.

Most of the Devonian fishes were placoid and ganoid. The placo-ganoids were shielded with defensive plates of armor, and these were of the most curious shapes. For example, some formed a kind of hat or hood for the head; in other cases a large bone formed a hood and neck collar; in other cases, again, a pair of plates, oreven a single one, formed a hood and mantle, as in the case of the Cephalaspis, *a* and *b*, Fig. 88, others, again, had the mantle without the hood, as in the case of the Pteraspis at *c*. Others, again, were armor plated in the vulner-



THE COLLIERY ENGINEER AND METAL MINER.
FIG. 89.

able regions of the head, shoulders and belly, as the Pterychthys *d*, and the Coccosteous *e*; others, of the ganoid type, were covered with bright, shining shell like scales of rhomboidal and other angular forms, as the Holoptychius *f*. In some the bony shields were composed of numerous scale-like plates, as the Pteraspis, and on others, again, the plates were of considerable size and jointed in composite order, as on the Pterychthys. Many were placoid and ganoid, that is, they were covered with plates and enamelled scales, as in the case of the Pterychthys. In many of these Devonian fishes, if such they may be called, we find what is really immature saurians, for the pectoral fins have become arm-like paddles, as exemplified in the Pterychthys. We see, then, that the life of the period was characterized by rudimentary forms in which small changes in their environment would at once develop extensions and suppressions in the cartilages of their immatureosteological structures. Fig. 89. The compensations in nature are very remarkable and the armor plated fishes were no exception to the rule, for all of them were slow and sluggish, and we are justified in this conclusion by three sources of evidence. The first is mechanical, for creatures so heavily weighted in the region of the head could not turn swiftly or swim quickly; therefore, their movements would be languid, and, again, nature never provides a means of defense for a creature that can act offensively, and in the third case, the ganoids that have continued from the Devonian period until now, as for example, the sturgeon and several others, found in the rivers of South America and Africa, are all sluggish in their movements. The lazy sturgeon is the scavenger that lies on the floors of the rivers catching what the stream brings to his mouth. The figure before us still further exhibits the peculiarities of the singular divergent forms of the period and furnishes examples of the spines of some of the gigantic placoids that flourished in these primitive seas, as the Osteolepus *a*, the Glyptolemus *b*, the Diplacanthus *c*, and the remarkable spines *d* and *e*. By Fig. 90 we are able to contrast the ganoids of the past and present, for *a*, the Lepidosiren, and *b*, *c*, *d* and *f* are living examples, as for illustration, *e* is the Auria of American rivers, known as the "Mud Fish." We now see that the life of the Devonian period furnished the rudiments of all succeeding life, both animal



THE COLLIERY ENGINEER AND METAL MINER.
FIG. 90.

and vegetable, and perhaps no other formation or life period has furnished so good an illustration of the reason why certain groups of the rocks have specific names, according to the characteristics of the organisms that flourished during their deposition.

[TO BE CONTINUED.]

CHEMISTRY OF MINING.

What Will be the Future Miner's Lamp.—Electric Lamps in Mines.—Velocity Testing of Safety-Lamps.

79. **What will be the future Miner's Lamp.**—We cannot undertake to say what will or will not be the future of the miner's lamp, for in these days the march of progress in science and mechanics is so rapid that what appears to us unassailable to-day is totally untenable to-morrow, and the greatest changes come without the warning of a prophet. A very short time ago we were told that the chemist had succeeded in liquifying air and now we find that the mechanic has succeeded in making liquid air a mechantable article for the worlds wants as a substitute for ice.

What effects us however, in the lamp question is this, liquid air only contains 30 per cent. of nitrogen and consequently 70 per cent. of oxygen by weight; for during the compression of the gases nearly 89 per cent. of the nitrogen in the air is set free as insoluble in the oxygen. The liquid air then consists of nearly pure oxygen and a little more than a pint or one pound of it would suffice to burn 4 ounces of oil, but the light would be so brilliant that 2 ounces of oil would be sufficient per shift to maintain a good light with the aid of half a pint of liquid air. Now such a lamp could be made to have no other connection with the external air, than by a funnel for the discharge of the inert gases produced by combustion, for the oil and the liquid air would be contained in close vessels completely isolated from the external air and the consequences would be the gauze cylinder could be dispensed with and the miner would be absolutely safe with his lamp in an explosive mixture.

Such a lamp may be tried, and it may be found to fail, for just as much was expected of the miner's portable electric lamp and up to now it has not displaced the safety oil-lamp, and perhaps never will.

80. **Electric Lamps in Mines.**—There are two distinct classes of electric lamps used in and about mines.

First. The magneto-electric current lights.

Second. The battery current lights.

The magneto-electric current lights are divisible into two kinds.

First. The arc, or fire stream lamps.

Second. The incandescent lamps having a glowing filament in a vacuum in a glass shell.

The battery current lamps are divisible into two distinct varieties.

First. Those having in the case of the lamp a primary battery of chemical cells, to supply the current for the light in a portable lamp.

Second. Those having in the case of the lamp, a secondary or storage battery to supply the current for a portable lamp.

All the varieties of electric lamps, further come under two heads, and these are *fixed* and *portable*. With the fixed lamps we have very little concern, as they are used more for efficiency and economy, than for safety, and it is, therefore, only with the portable lamps that we are interested as they have been introduced as a means of safety in mines.

The draw backs to portable electric lamps may be classed under five heads.

First. They can only be recharged and kept in working order by skilled men.

Second. They are costly at first and expensive in maintenance.

Third. They cannot be used to indicate the presence of fire-damp.

Fourth. They are too heavy to carry in the hand.

Fifth. They give a relative small light for the prime cost, and that of future maintenance.

To realize correctly the value of the facts enumerated you only need to contrast the first, with the latest examples of the miners electric lamp; for all the makers are now aiming at the production of a lamp that will be free from the faults we have noticed. One thing, however remains that cannot be otherwise and that is a portable lamp, must always be a battery lamp, and this means that to obtain a good light, you must have a heavy lamp.

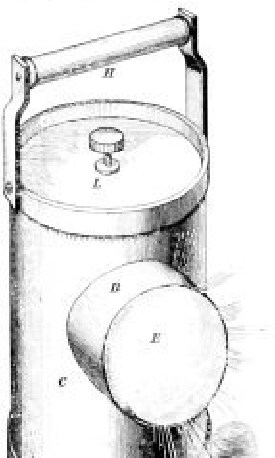


FIG. 119.

FIG. 119 is an illustration of the Bulls-eye lamp with a primary battery. Now as we have just indicated, it is impossible to obtain with a primary battery of small cell's that can be contained in the case of a portable lamp, a high voltage and a small resistance, without at the same time introducing a high chemical potential with the resulting corrosive action in the cells, and therefore an economical light under the circumstances is impossible and the result of this is, we see that a very small filament or very small lamp is used, and it is expected that by this means a light will be obtained that will rival the oil flame of an ordinary lamp, and thus solve the problem of electric illumination. Now it so happens that a few intense beams of light that illumine a small circular area and leave all outside of that field of view intensely dark, baffle the human eye, and jeopardize the miners life. This may seem a strong assertion but the conclusion can be established by proof. The iris of the eye or the curtain that gives the characteristic color of blue or grey eyes, contracts and diminishes the pupil in a bright light, the result is blindness in a subdued light, and what makes the matter worse is the fact that the iris or curtain is not subject to volition or the power of the will, but is under the control of reflex action, or it is only made to contract or dilate in obedience to the stimulus of light. All miners know that they have to find their "pit eyes" on entering the mine from a cage in a vertical shaft. With a slope it is somewhat different as they leave the light by slow gradations of change. The small bright bundle of rays of light is then a source of danger, and a much weaker light more widely diffused is a source of increased safety, as the miner is never safe unless he can see the floor, and the roof and the sides, without much handling of his lamp. At C we have the case, E is the bull's eye, and L is a contact maker or breaker for shutting the current off or on. This lamp is actuated by a primary battery and only casts a bright beam of light in one direction. Fig. 120, is an example of an up and all round light sustained with a current of high voltage from a storage battery, and the vacuum glass is seen to be protected in a cage of strong wire. This lamp gives a powerful light and but for its weight and cost would no doubt be a success. The uses of the different parts of this lamp are as follows: B is the chamber containing the storage battery, CC are the cage bars for protecting the glass shell of the lamp, and LL are the terminals of the carbon filament.

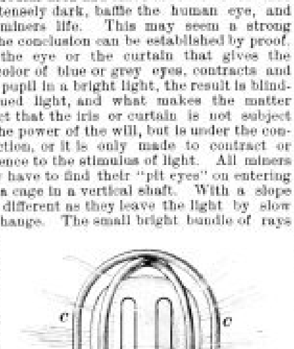


FIG. 120.

81. Velocity Testing of Safety Lamps.—Lamps are tested with the view of finding at what velocity they will pass the flame and explode. In the past the "explosive mixture" was prepared without regarding the difference between a simply explosive mixture, and a true *maximum* explosive mixture, or one in which one volume of marsh gas was mixed with exactly 9.5 volumes of pure air.

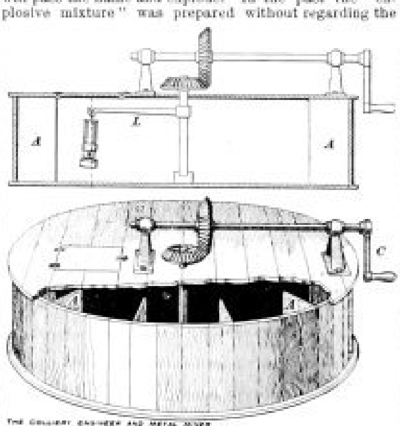


FIG. 121.

No tests with safety lamps are, however, of any value unless the mixture in which they are tested is of determinate and standard proportions, and therefore it is of all things most important that the volumes of air and gas should be correctly measured for the test. The mechanical arrangement illustrated in the Fig. 121, is a tester, and perhaps is the oldest or most primitive one in use, and therefore is not one of the best, but it answers our purpose best for illustration and explanation. Here, then an upright shaft with a crown wheel on its upper end, and an arm keyed on just below the cover at L, is made to turn by the handle C, and revolve the lamp that is hanging on the end of the lever L. To prevent the rotation of the air within the case, arresting blades A A, etc., are fixed within the shell of the cylinder. Now it is not necessary to say more about the apparatus, as its mode of action is evident at sight, but the length of the circle in which the lamp turns, and the number of turns per minute have to be found, so that the velocity of the lamp in feet per second may be determined, and this having been done, all lamps may be tested in a uniform velocity, and yet the velocity per second at which any lamp will explode in a unit of time, can from the time of the uniform velocity be determined, as the times are inversely as the squares of the velocities. For example, the Davy lamp "fires" in one second, when the velocity of the explosive mixture is at the rate of 6 feet per second and at a velocity of 4 feet per second the time, therefore, is $\frac{6^2 \times 1}{4^2} = 2.25$ sec.

That is, to say a lamp that fires in one second, at a velocity of 6 feet per second, will fire in 2.25 seconds at a velocity of 4 feet per second. Or the velocity per second at which any lamp will fire, can be found if the velocity per second at which it has fired, and the time are given; because if the velocity is multiplied by the square root of the time, we find the velocity for one unit of time as in the case before us is $\sqrt{2.25} \times 4 = 6$ feet per second, the velocity at which a Davy lamp fires in one second of time.

We see then that the velocities increase or decrease the time; for example, a velocity of 12 feet per second will cause a Davy lamp to explode in one quarter of a second, as $\frac{6^2}{12^2} = \frac{1}{4}$.

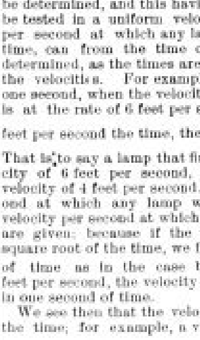


FIG. 122.

Fig. 122, is an illustration of a Davy lamp, and it is interesting to observe the entry of the fresh air, as shown by the *sagitta* or arrows at d and d, the exit of the inert air as at e and e, and f and f, and at the top of the cap at g.

The only protection provided against the passage of the flame in this lamp is the gauze cylinder; and, therefore, when the lamp is exposed to an air current moving at a high velocity, the displacement of the dead air and the entry of mine air that may be charged with gas, takes place also at a high velocity, with the result that the lamp becomes full of flame, the gauze becomes heated to redness and the passage of the flame through the gauze follows.

Such a lamp as this has a small motive column for obtaining a supply of fresh air or effecting the discharge of the foul air from the lamp, and, therefore, a draught may increase the ingress and egress many times and convert the interior of the lamp into a veritable furnace. This lamp in its original form is now a thing of the past, and it is chiefly used now in a can with a glass pane for the passage of light. The can is a screen that prevents the rapid entry of gas-charged air, and thus secures the safety of the lamp. At T is seen the oil fountain, and at F, the bottom ring in the lamp frame, that is seen to be screwed onto the top of the fountain. The wick is shown passing up the wick pipe, and a slit is shown in this pipe at B, for the entry of the pricker's point A, to adjust the length of the wick and the flame.

82. Safety Lamp Dimensions.—Fig. 123. The writer remembers seeing some lamps at the Blantire Colliery in Scotland, at which an explosive mixture was fired. They were rude copies of the Davy lamp and consisted of a large gauze cylinder with a conical cap. The lamps for the "hewers" consisted of a gauze cover 7 inches high and four inches in diameter, with a rude, vulgar looking hook riveted onto one side of the gauze, and this cover and hook was fitted onto a ruder oil well, and, altogether, such a lamp could be little, if any, better than a naked light, but this example of a safety lamp taught a lesson, and that was that the cubical contents of a gauze cylinder are an important matter in the construction of a safety lamp, for in the first place, the volume of mine air entering such a lamp in a draught will be proportionate to the surface area, and as the explosive force of gas that fires in such a lamp, will be in the proportion of the cubical contents, we cannot wonder at the risk and danger that such a large lamp engenders. To enable the reader to realize the magnitude of the danger, let us look at A in the figure and contrast it with E, and the instinctive feeling set up by a glance makes you feel that an explosive mixture in A, if ignited, would pour into the meshes of the gauze such a flood of flame that the wire would at once become hot and allow the fiery stream to pass on unobstructed; whereas, in E the volume of flame would be small in proportion to the surface area of the gauze, and, therefore, a lamp with the small gauze cylinder would secure greater safety and protection. It is easy to see, then, that the relative safety of every gauze in the series A, B, C, D and E is inversely proportionate to their size.

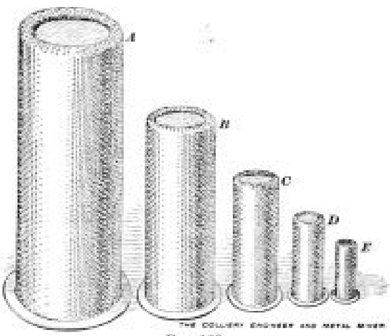


FIG. 123.

(TO BE CONTINUED.)

MISCELLANEOUS.

FLORIDA PEARL FISHING.

A writer in the *N. Y. Sun* thus describes his experience on a fishing trip with two Florida pearl fishers:

The Pickles are a collection of rocky islets lying out beyond the outermost keys, with the shoal water of the reefs on one side and the deep channel of the Straits on the other; and to reach them it was necessary to cross Florida Bay, and run across the outer reefs—a sail of some hours.

"Off the Pickles you can have the water about any depth you want," the diver said, "say from 30 feet to 250. The bottom comes in ledges, and a man can go down thirty or forty feet to a ledge and step off that right into thirty or forty fathoms. Conchs are plenty there, because the ordinary fishermen don't care much to go down after them."

"We're none too soon," he said, when the sharpie, with sails lowered, lay outside the Pickles. "The nearer the sun is overhead the better for this deep-water work. Not much use trying it on a dark day or after the sun has gone down. You'll not see any bottom here," he went on, turning to the stranger, "not even with the sun overhead."

The water was as clear as in nearer the keys, but on account of its great depth nothing could be seen below but a mass of deep green. Hawley produced a great coil of rope from a locker under the stern seat, rope slightly thicker than a clothesline, and carefully made one end fast around a huge piece of coral rock that lay on the boat's bottom amidships. This rock was as big as five or six full-grown heads and had been useful throughout the voyage for ballast. But a deep notch chiselled all the way around it in the centre, and the tying of the rope around this notch, showed that it served another purpose. When one end of the rope was secured to the stone, the other end was made fast to an iron ring in the sharpie's bow. The diver then slung an old coffee sack over his shoulders, after the fashion of a pair of saddlebags, having a slit in both sides, and a stone in each end to keep them from floating up.

"Now you'd better sit here on the starboard thwart to balance me," he said to the stranger; and when this was done he lifted the big stone to the opposite thwart and threw off his hat.

The stone apparently weighed in the neighborhood of a hundred pounds, and balancing it neatly on the narrow ledge, he climbed over the side into the water and rested there holding on to the thwart with one hand and keeping the stone in place with the other.

"Keep that line clear," he ordered, but before there was time for a reply the stone toppled over into the water, and stone and diver disappeared together.

The line paid out with some rapidity, but not so fast as might have been supposed, for it was evident from the manner of the taking off that the stone was merely a sinker to carry the diver to the distant bottom. After a long interval the line ceased to run out, but more than half of it was still left in the coil.

"Will he give the signal when he's ready to be drawn up?" the stranger asked.

"Drawn up!" the skipper exclaimed; "he'll not need any drawing up. When he's ready to come he has only to let go of the stone, and he'll shoot up like a flash. It's no trouble to come up; the only difficulty is about getting down. I don't know just how deep the water is here, but if it's more than fifty feet a man would have hard work to get down without weights."

While the skipper was speaking the diver's head appeared at the surface ten or fifteen feet away, and he immediately struck out for the boat.

"You fellows draw up the stone while I unload," he said, resting with his hand on the side of the boat. "I may as well get a load while I'm about it."

"How deep did you go?" the stranger asked, while the diver took conch after conch from his bag and dropped them into the boat—twenty-two in all.

"It's about 15 fathoms here, 90 feet," he replied, "and it gives a man a buzzing in the head, but that soon goes off. This is one of the best conch beds along the whole coast, I could fill the boat in no time."

The stone was up at the surface by this time, and with a look at the wet line to see that it was properly coiled, he disappeared again. The period of submersion each time was estimated at about three minutes; and after the third descent he climbed in over the stern and the stone was taken on board.

"That will do for to-day," he said, "for we have a long sail yet before supper. I could show you some conchs from deeper water than this, but this shows you how the work is done. Sharks?" he repeated in answer to a question; "Humbug! I never think about them, and I guess they never think about me, so we have no trouble."

Darkness fell before the sharpie reached Shell Key, and the conchs were piled up on the beach to wait till morning. The diver was too old a hand at the business to have any great curiosity about his find. There might be a fortune in pearls lying there on the beach, but he slept unconcernedly on his coconut mat till time came for the midnight smoke.

When the seventy conchs were opened and examined in the morning, they gave up one little yellowish pearl, that he said would be worth about eight shillings in Nassau. It was no larger than a small pea, and imperfect; and it came from one of the gnarled conchs of Blackwater Sound.

"It's all right," said the diver, "I've done many a day's work for less than that."

THE WORLD'S HOLIDAYS.

Thanksgiving Day comes nearer even than the Fourth of July to being a legal national holiday, for altogether the Fourth of July is celebrated in some parts of the country where Thanksgiving Day is neglected, the President's proclamation gives to the latter a sort of official character that the former has not obtained. It is not for the Federal Government to tell the people of the United States when they shall quit business and take to pleasure. It is a matter for the States to establish legal holidays. The President in his Thanksgiving proclamation merely recommends that the people, neglecting their ordinary vocations, observe the day with proper ceremony.

As a matter of fact, the people of the United States work harder and have fewer holidays than any other people in the world. This is not especially a characteristic of democracies, however, for the Australian colonies, which are hardly less democratic in their local government than the United States, keep more holidays than any other country in the world. All the important sporting events, whether cricketing or racing, are made the excuse for a general holiday.

The usages as to holidays, legal and otherwise, in the several States of the Union greatly vary. Louisiana seems to have more holidays than any other State. It observes Jan. 8, the anniversary of the battle of New Orleans; Mardi Gras, on the eve of Lent; Feb. 22, Washington's Birthday; March 4, firemen's anniversary (in New Orleans), Good Friday, July 4, Labor Day in November and not September, as in most States, Christmas Day and New Year's Day.

Lee's birthday, Jan. 19, is a holiday in Georgia, North Carolina, and Virginia. Lincoln's birthday, Feb. 12, is a holiday in Illinois.

Texas makes Feb 2, the anniversary of her independence, a holiday, and also April 21, the anniversary of the battle of San Jacinto.

Alabama and Georgia have a memorial day, or Decoration Day, on April 26, and North Carolina on May 10. North Carolina also celebrates, ten days later, the anniversary of the Mecklenberg Declaration of Independence. Florida celebrates Jefferson Davis's birthday, June 3. Utah keeps Pioneers' Day on July 24. California keeps Admission Day on Sept. 9, and Nevada on Oct. 31. South Carolina keeps not only Christmas Day, but Dec. 26 and 27 as well. This, doubtless, is a relic of slavery times, when in many parts of the South the negroes kept the whole week between Christmas and New Year's, when little or no work is done. It is was a sort of truce of God for the slave, who for the week lived as a free man and made merry.

Arbor Day is observed in a constantly increasing number of States, and the Saturday half holiday is gradually extending from State to State, though it is not strictly observed anywhere.

Great Britain really has no public holiday that corresponds to the Fourth of July. There is no day when Britons of every political party and faction come together and celebrate in hearty accord a national event. Christmas is not even a legal holiday in England, though it is in Scotland. It is, of course, celebrated throughout the kingdom, but it was made a statutory holiday in Scotland, because otherwise the strong Puritan spirit prevailing there would have brought about a neglect of the observance. In London the Saturday half holiday is as much observed as Sunday. The Bank Holiday act, passed at the instance of Sir John Lubbock in 1871, made four legal holidays, Easter Monday, Whit Monday, the first Monday in August, and Dec. 26. In Scotland the legal holidays are New Year's Day, the first Monday in May, the first Monday in August, and Christmas Day. Christmas Day and Good Friday are holy days, but not legal holidays, in England. On these days all the theatres are compelled to close. New Year's Day is the great holiday in Scotland. It is much more widely observed than Christmas Day, while New Year's Day is not observed at all in England. Guy Fawkes's Day, Nov. 5, is kept after a fashion in England, but it is not a day that Catholics care to remember, since it recalls a time when they were hated and suspected. The French observe New Year's Day, Jour de l'an, in great pomp. The glory of that day has faded in New York, and New Year's calls are about extinct, except that in some of the old American quarters over on the west side, in some of the long ago fashionable streets, the day is still remembered. The people keep open houses, eggnog and other drinks are provided, and there are callers all day long.

The Queen's birthday, which is totally neglected in Great Britain and Ireland, is observed with great enthusiasm in most of the colonies, especially in Canada. It is to the colonial Briton a rallying day that comes nearer the Fourth of July than any other in the year. The Canadians also have an annual Thanksgiving Day, generally a week earlier than ours.

Scotchmen of all classes rally on St. Andrew's Day, and this is really a very important day in the English colonies, for Scotchmen have in large part made the colonies of Great Britain, and they are strong, the world over, wherever the British flag flies. St. Andrew's Day is celebrated in China, in Malaysia, all over India, in South Africa, in Australia, in Canada, and in a hundred insignificant islands and small settlements. Burns's birthday is another Scotch holiday, though, of course, not a legal one. It is celebrated wherever Scotchmen are. St. Patrick's Day and Orange Day are familiar to all sorts of people wherever the warring factions of Irishmen are found. The Welsh celebrate St. David's Day at home and abroad.

Englishmen in India keep not only their own but also the native holidays. There is Holi, a carnival of license, when the natives go about striking each other with bags of red powder, and their white garments are dusted as with red pepper. There is Dipwali, the feast of lanterns, celebrated in gorgeous fashion not only all over India, but in China and Japan, a beautiful and, to the stranger, marvellous holiday. There is Dasera, when all the animals are decorated with flowers, and masters are expected to give presents to their servants in recognition of the holiday. This corresponds to Boxing Day in Great Britain, Dec. 26, when postmen, street sweepers, servants, and employees of every class expect presents. Nearly every country has such a gift-exacting day.

The Saturday half holiday is one that has existed in fact for a long time in various parts of the United States. For many years it has been the practice of working people on the Eastern Shore of Maryland to quit work at noon on Saturday and to spend the rest of the day fishing, hunting, or carousing. That is the day when the country negroes come to the villages; indeed, when all country folks visit the town. It is sometimes called Public Day, being the day when country folks drive to town to make their purchases. The village stores keep open later on Saturday night than any other night in the week, and every considerable village becomes a sort of business and social exchange. There is a disposition in New York city to extend the Saturday half holiday through the whole year, and many self-employing men quit work at noon on Saturday the year round, in order to make excursions into the country that shall last over Sunday. Whit Monday is a holiday among Southern negroes. They commonly call it "Whistling Monday." In those Southern States largely settled by Catholics or Episcopalians the colored people still celebrate feast days and fast days. The old New England Fast Day seems to be dying out.—*N. Y. Sun.*

ALONG THE YUKON RIVER.

On account of the rich gold finds which have been discovered in Alaska and the resulting boundary dispute which is threatened, much interest has been excited. Most people, however, who have not made a study of the subject have a very vague idea of the nature extent and value of the region. Mr. C. A. Weare, treasurer of a company trading in that region in an article in the *Chicago Inter-Ocean*, thus describes the Yukon River and some of the neighboring regions.

"The Yukon River is navigable for about 1,800 miles for steamboats. It has five outlets, and yet, as I have intimated, no direct, practicable channel to the ocean has been discovered heretofore, its mouth at this season of the year being, for about forty miles, filled with bars and islands. For some 600 or 800 miles up the river the water is very deep, and would be navigable by middle-sized ocean steamers if there were any way to get in over the sand bars at the mouth. The river averages from one mile to ten miles wide for 800 miles, and above that it averages about one and a half miles wide for the next 800 miles. The waters of the Yukon drain a country in extent as large as the United States east of the Mississippi River. The country is mountainous, but the mountains are not very high. They have evidently been ground off by the glacier period in these canyons. The valleys are filled in with these washings from the mountains, and it is in these canyons and valleys that the gold dust is found, along the sides of these hills and mountains. It is found everywhere along the Yukon River and in the sands of the river. It is estimated that about $2,000,000 to $3,000,000 of gold dust has been taken out of the Yukon River in the past five or seven years, but a record of it does not appear in the public record, for the reason that the miners bring it out, as a rule, go to the first assay office and pass it through and sell it, without mentioning where it is from, and the Yukon never gets the credit for it. Usually the country, where the mine or assay office is situated, is the country that gets credit for the production of that gold. I mention this because it looks to a person who is interested in that country that the United States Government is not fully alive to the situation and to the magnitude and value of the country that we own there. The Canadian Government is fully alive to the situation, and has already placed officers, among whom is a magistrate, with a mounted police force numbering twenty-two men, to look after the people of the Canadian Government in the Yukon country. The dividing line between the British country and the United States on the Yukon is a little southeast from the Arctic circle, so that a good deal of the valuable gold country lies not only in the United States, but in the British Northwest.

"I look for a great future when the country is opened. Of course, it is now very new and crude, and the kind of people who are needed to develop it are sturdy miners who have some money to take with them, so that in case they do not happen to get a good 'prospect' immediately, they will have something on which to depend. It won't do for the ordinary run of humanity to go into that country without money.

"The country produces gold and furs in quantity. We brought down our usual collection of the latter, such as bear skin, marten, sable, silver fox, cross fox, and red fox, beaver, otter, mink, lynx, and on the coast quite a quantity of hair seals are taken, this being too far north for the fur seal.

"Another matter which should be of great interest to the people of the United States is the opportunity offered for the fishing industry along not only both sides of the Aleutian Peninsula, with its myriad islands, but the entire western and northwestern coast of Alaska, from Norton Sound to the mouths of the Yukon and the Koskoquin. There are fishing banks, both of cod and halibut, extending through the entire district mentioned, and all the rivers running into these different islands and coasts at the proper season of the year are full of salmon. The natives of the Yukon country consume salmon as their principal diet, and upon it even feed their dogs. Their dogs are their beasts of burden. They do their travelling in the winter, over the snow or ice; they dress in skins; in fact are Eskimo. The Indians of the northern Arctic coast and the lower Yukon River are short, fat, sturdy people, good natured, and usually honest, while the Indians of the Yukon River are more genuinely Indians—short, slight in build an active, hardy race, and yet from the nature of their food—mostly fish, with some game, of course, are a species of Eskimo.

"It would be greatly to the advantage of the United States Government that more interest be taken in that country, and that a proper survey be made of that great river and its mouth, as also of the proper line between the British Northwest and our Alaska."

DOCTOR OF MACHINERY.

Among the multitudinous trades and professions there are many which are entirely unknown, even by name, to the general public. One of the least known and most interesting is that of the expert in machinery. The work of a machinery specialist is far higher than that of a skilled engineer, and many years of experience and special training are necessary to fit the expert for his duties. There are only about half a dozen of these men in the country, one in every large city. When anything goes wrong with a machinery plant of whatever nature, the cause of which the engineer in charge, frequently the builder of the engines, cannot discover, the machinery doctor is called in. Every chief engineer of a big plant may be called a specialist so far as the machinery under his charge is concerned, but the specialist in machinery is an expert in engines of every description.

Though he has never seen the engine before, he rapidly diagnoses the case and prescribes a remedy, just as a doctor does for a sick patient. The instrument most used by him is a dentophone, which consists of a thin steel rod about a foot long, which he holds between his teeth and applies to the head of the cylinder. To the practiced ear of the expert every sound transmitted from the cylinder tells a story. The working of the piston in the cylinder, and, indeed, of the whole engine, can be heard distinctly in this manner by anybody, but it takes an expert to tell just what those sounds mean.

In the case of a mysterious knocking which was heard in the cylinder of the big driving engine in a large spinning factory not long ago, an expert was called in to determine the cause. Every method had been tried to discover where the trouble was, but without avail. Bearings were examined, the cylinder was taken apart, and every part well oiled, all to no purpose. When the expert came he traced the mysterious knocking from the cylinder, along the piston rod, crank shaft, and through the main shaft, away off among the looms, where one of the looms was found to be the cause of the trouble.

Often an expert's services are required in the case of synchronizing looms. If all the looms in a big spinning factory happen to beat together, as sometimes happens, the vibration is strong enough to bring the building down. For the same reason soldiers always break step when going over a suspension bridge, for otherwise the measured tramp of the many feet all striking the ground at the same time would seriously endanger the structure. The power of sound is also enormous when exerted in a particular way. Every substance in nature has a keynote, and when a sound of the same pitch is caused near it a considerable amount of vibration is produced. When the great tubular bridge was being built across the Menai Straits, which divide England from the island of Anglesea, a traveling violinist nearly caused the collapse of the whole structure. He happened, while playing, to hold for a considerable time a note which chanced to be the keynote of the huge bridge structure. The sound echoed along the vast tube and re-echoed with ever-increasing force until the whole bridge vibrated as if an earthquake were taking place. The bridge engineer, who was near by, instantly divined the cause, and stopped the playing of the violinist.

Part of the business of the machinery doctor consists in so arranging the distribution of looms and other machinery that their working will not endanger the stability of the factory. Defects in a boiler can also be instantly determined by the practiced ear of the specialist. A plate in the boiler is selected which is known to be in good condition, and he takes mental note of the pitch of the sound made when the plate is struck with a hammer. All the other plates are struck in the same way, and any one which does not ring true and conform to the correct pitch is examined and replaced. A case is on record where a machinery specialist was crossing the ocean and detected crystallization in the center of the shaft, thereby averting what might have been a serious accident in midocean. Measures were taken to strengthen the shaft to the place where the quick ear of the expert detected weakness, and when the vessel was docked his suspicions proved correct.

Few men, even with the most exhaustive training, can become experts at this business, as it requires a marvelous quickness of ear and delicate perception of sound with which few men are blessed. Technical knowledge is of little avail of itself, and a fine engineer might be a poor machinery doctor, just as a great musician might make an indifferent piano tuner. Whenever a big mill is erected, a specialist is always consulted as to the placing of the machinery, and his fee is generally well worth the expense and trouble which an injudicious distribution of machines may cause.—*N. Y. Tribune.*

AMBERGRIS.

What is ambergris? In the "Arabian Nights" we are told of Eastern beauties whose cheeks were marked with moles like bits of ambergris, and in the story of the sixth voyage of 'Sinbad the Sailor" we read in the description of the place where the voyagers were wrecked. "Here is also a fountain of pitch and bitumen that runs into the sea, which the fishes swallow and then vomit it up again, turned into ambergris!" That antique author, Robert Boyle, considered it to be of vegetable production and similar to yellow amber; thus it received its name, amber-gris—gray amber.

This and other even more plausible theories are but indeed fallacies that puzzled savants have set forth when they were at a loss to account for its origin. It is now ascertained beyond a doubt to be generated by the large-headed sperm whale and is the result of a diseased state of the animal. The victim of this rare malady may possibly throw off the morbific substance, or finally die of the ailment. The disease is located in the intestinal canal, and some savants suppose it to be caused by a biliary irritation. After a deep study on the subject several modern scientists have agreed that the disorder is akin to to that now fashionable human peril, appendicitis, intensified and prolonged in this great mammal, yet that dread ailment that has but lately been understood by the surgeons and medical men of the world.

It is known that the ambergris whale feeds upon the cuttlefish. This creature is armed in its head with a sharp-pointed curved black horn resembling a bird's beak, much like that of a parrot, only the lower mandible is the larger. This is found—as it is too indestructible to be digested—in many specimens of ambergris, and may oftentimes aid in establishing a seated disease. It may be considered, though, to be but the primary cause of irritation, as much of the finest ambergris is entirely free from the tough little horns. Such is the effect in the whale of the magnified—and tremendously magnified—illness which, when established in our own comparatively puny organism, causes an instant and fatal collapse unless quickly and heroically attacked by the skill of the surgeon. The habits of the great water mammals, however, tend to prolong life, and their resisting power against the insidious destroyer is eloquent of their tenacious hold on existence.

To the conservative whale fisher of New Bedford or Provincetown, the discovery of ambergris is as unexpected and as longed for as the sheeny splendor of the pearl that gladdens the pearl fisher. Almost awe-stricken are the sailors when the cry of "ambergris" is uttered. This is the happy event of a lifetime. The substance is carefully taken from the bowels of the whale and is packed in casks if it is in liquid form, or in sacks if it is dry enough.

It is then brought direct to Boston, where it is appraised by the head of the largest wholesale drug firm in the city. This young man has no enviable task before him in ascertaining the value of the article. He has to examine the fetid mass, which is sometimes in a rank liquid state, sometimes of the consistency of soft putty, and again a chalklike substance. That which is more like putty usually is to be relied on for making the best market ambergris, and gradually, as it dries, the only curing process it undergoes, the unwholesome dark shade turns to a soft squirrel gray. The substance lightens in weight, developing a fascinating odor almost indescribable, like the blending of new-mown hay, the damp woody fragrance of a fern copse, and the faintest possible perfume of the violet.

And to what use is ambergris put? It is an indispensable article with fine perfumers, as it is used to give permanency and lasting qualities to very fleeting scents. It is a curious fact that the keynote or basis of "nosegays" or "bouquets," as handkerchief odors are called, is not, as one might suppose, the attar of garden flowers, neither the penetrating balsams. These are indispensable, but are not the groundwork. That basis is always one of the four animal odors, *i. e.*, ambergris; musk, obtained from small musk deer of Asia; civet, from the civet cat of India, and castor, a secretion of the castor beaver, and now almost obsolete in the perfume trade. The pure and separate tincture of any one of these odors is too intense and powerful to be tolerated. Like all substances of these kinds, it must undergo a slow decomposition, till the remainders possesses very little volatility. Even then they contain a virtue which clings pertinaciously to woven fabrics, and not being soluble in weak alkaline lyes, are still to be detected in the material, after passing through the severest lavatory ordeal. They are, therefore, of great value to the perfumer, and are the foundation in almost every formula.

The price of ambergris varies from $5 per ounce to as high as $30 for the finer qualities. It is told that as much as 150 lbs. was found in one whale by a lucky crew and the prize was worth $60,000; and among the whale fishers the possibility of such a find is dreamed of in the same way as the drawing of the grand prize in the lottery or the finding of Captain Kidd's gold is thought of by other people.—*St Louis Globe Democrat.*

LIQUID AIR IN COMMERCE.

An interesting illustration of the rapidity with which purely scientific discoveries frequently become the starting point of new industries is furnished by the case of liquid air. It is no long time since liquid air was produced for the first time in quantities great enough to admit of its application for purposes of research; yet steps are already being taken to treat liquid air as an article of commerce, and to turn it out upon a large scale. As in most cases of the kind, laboratory methods require modification to suit the needs of wholesale production. Patents are being taken out for machinery which, though constructed upon the principles of that used for purposes of research, will attain the desired end with greater directness and with the omission of several intermediate steps. The necessary reduction of temperature to the critical point of air has hitherto been effected by the successive employment of liquefied gases boiling at lower and lower points on the scale. But the final decrement of heat has been won by the cooling effect due to the rapid evaporation of the product itself. The new apparatus dispenses with the use of these intermediate cooling agents, and relies entirely upon initial compression by powerful engines and subsequent partial expansion of the compressed air under carefully regulated conditions. Most people probably have seen at one time or another the familiar lecture-room experiment of forcing a piston suddenly down a cylinder, and showing the ignition of a scrap of touch-paper by the heat thus produced. If while the compression is maintained the cylinder and its contained air be cooled to the original temperature, then, on suddenly withdrawing the piston and allowing the air to regain its original volume, there will be a fall of temperature corresponding to the rise on compression. If now the cooled air could be used to reduce the temperature of a second quantity of air before expansion, it is evident that, starting from a lower point than the first batch, the second would on expansion reach a lower point. This is the principle of the new liquid air apparatus. A powerful engine compresses air, which is cooled as far as possible by ordinary refrigerating methods, and passed into a spirally coiled pipe, over 100 yards long. This pipe is enclosed in a second spiral. By means of a throttle valve at the end of the inner spiral a certain proportion of the compressed air is allowed to expand in the space between it and the outer pipe. Thus the stream of compressed air from the pump is cooled by that portion which has been allowed to expand, and arrives at the throttle valve in a colder state than the portion that preceded it. Consequently it reaches a still lower temperature on expansion, cooling yet more powerfully the advancing stream in the inner tube. By carrying this cumulative cooling effect sufficiently far, the circulating air is at last brought down to its critical point and liquefies, after which a continuous stream of liquid air is merely a question of engine power. It is impossible without the aid of diagrams to explain clearly how the continuity of the process is maintained, but the cycle of operations can be readily apprehended. There is compression, expansion in a closed chamber, and utilization of the cold thus produced to repeat the cycle from a lower initial temperature. The inventor, Herr Linde, who is a man of great experience in refrigerating machinery and methods, believes that a large demand will shortly arise for this most powerful of all refrigerators. In the meantime his apparatus produces with the greatest ease a substance for which there is already a large industrial demand—oxygen gas. During the process just described the air becomes steadily richer in oxygen until that gas forms some 70 per cent. of the product. This relatively pure oxygen is sufficiently good for certain purposes, and it may be further purified from nitrogen if desired. The price of oxygen gas thus obtained compares favorably in respect of cost with that produced by the methods now in use. It would have been gratifying to have been able to announce that this commercial application of recent scientific ideas, so closely associated with the Royal Institution, had been made in England. But, unfortunately, in this, as in so many other cases, it has been "made in Germany," where there is at present far more alertness and a far higher standard of technical knowledge than among ourselves. It is obvious from what has been said that this process is an affair of engineering far more than of chemistry. This remark applies to many of the most important and lucrative manufacturing processes of the day, and, unhappily, engineering, chemistry, or chemical engineering, is just one of the things in which the Germans are conspicuously superior.—*The London Times.*

UNDERGROUND WATER

"Stories about a great subterranean lake or sea beneath Nebraska, Kansas and a part of Indian Territory are going the rounds of the press," said Robert T. Hill of the United States geological survey. "They are accompanied by details relating to the bottomless ponds occupying areas where patches of land have sunk and disappeared. Other reported phenomena, supposed to be in the same connection, are roaring wells in which water ebbs and flows.

"Such tales become current periodically. So far as the wells are concerned, they are based on fact. I, myself, have seen a number of wells in which the water rose and fell at intervals. This is not an uncommon phenomenon in parts of the West. It has a relation to changes of the barometer. When the barometer is high, the pressure of the atmosphere being greater, the water in such wells and springs stands at a low level. On the other hand, when the mercury in the glass is low, the diminished pressure permits the water to rise. The surface level varies from day to night, for the same reason.

"There are many phenomena connected with Western wells and springs which are calculated to excite the attention of the observer from the East. They are puzzling sometimes even to a scientific student. I have never seen a well that roared, but I know of no reason why such a thing may not happen. There are wells from which currents of air come up. Stories are told of magnetic wells, in the neighborhood of which the needle of the compass is affected. I never saw one, and no facts appear to support this peculiar yarn. Water is the most common substance in the world, and there is nothing about which so much humbug exists.

"The most remarkable well I have ever seen was on the old battlefield of Stone River in Tennessee. A man digging for water struck an underground stream. He made the hole big enough to hold a water wheel. The stream ran the wheel and pumped water up to the owner's house. Underground streams, of course, are common enough. They are frequent in the limestone region of Texas, in the gypsum region of New Mexico, in the Appalachian region, and in the limestone region of Iowa and Missouri. The very fact that these streams are flowing shows that they are seeking a base level, and hence it is useless to try and tap them by artesian wells, because the water will not rise.

"There is no such thing in the world as an underground lake or sea. Nevertheless, such lakes have been created frequently by the imagination of hopeful settlers in the West. The truth in this matter was established years ago by the Government engineers who, under the direction of Col. Nettleton, journeyed across the great plains of Kansas and Nebraska. They sounded every well they could find, studying the underground water. Of the fact that there was no underground sheet of water they made certain. The wells were like any other wells, the water coming from saturated rocks below the level of surface evaporation."—*Pittsbury Commercial Gazette.*

REVERSAL IN INVENTION.

Mr. Edward P. Thompson, in an article in the Journal of the Franklin Institute, entitled "Reversal in Invention," points out a simple fact that may be of the greatest use to future inventors, as it certainly would have been to inventors in the past. He reminds us that a large number of important devices may be sorted out into pairs, one of each pair being what he calls a "reversal" of the other. Thus, the dynamo, which transforms mechanical into electric energy, on being reversed becomes the motor, which changes electric energy back again into the mechanical form. Now if this principle of reversal had only been recognized long ago, each of those pairs of inventions would have required but a single inventive act, instead of two entirely independent ones. Both the invention and its reversal would have been devised at once, instead of by different persons going through different trains of thought at widely different periods. We quote a few of Mr. Thompson's illustrations of these "reversed" inventions:

"At the time the microscope was invented the principle of reversal could have been applied by reasoning that, if a distant large object could be made to appear nearer, could not a near object be made to appear larger? Had this idea been created, the mechanical execution could have been carried out by experiments with lenses of different convexities, concavities and numbers.

"A reversal of the telephone, which causes distant sounds to appear near, would be a microphone, but the present instrument is improperly named, as it does not enlarge, but simply creates a sound. When first invented its wonderful power was spoken of as making the walking of a fly sound like thunder, but this is false, because the fly jarred loose carbon electric contacts, thereby causing great fluctuations of current and violent action of the receiving telephone. . . . .

"The present air brake system is now recognizable as a reversal of the early type, but a long time passed before the change took place. The principle had not been used as a kind of tool, and, therefore, the idea of the new brake did not come by demand of the mind, but by a combination of circumstances, that is to say, accidentally. The two systems of brake referred to are perhaps already conjectured by the reader, the first operating to stop a train by the positive action of compressed air against the wheels through the medium of the usual brake shoes, and the second by the negative action of compressed air, which normally holds the shoes away from the wheels in opposition to a spring. The advantages of the second way are apparent as soon as compared as to their main object, safety; for, by the former the train cannot be stopped in the case of leak or a disordered pump, while with the latter the train stands still as soon as the air leaks out or the pumps refuse to work. . . . .

"The mental process of investigating this subject makes the principle so simple that it is a wonder that inventions existed so long before their opposite phases were thought of. Electricity furnishes several examples besides the dynamo motor example, where the principle was not applied by a predetermined act. The old form of burglar alarm had an open circuit, and the process of opening the window closed the circuit and rang a bell. The reversal of this is a normally closed circuit. The opening of the window breaks the circuit and the bell rings. The idea once gained, and the advantages are apparent, for an alarm is given if the burglar cuts the wire. . . . .

"The storage battery, although condemned for railway traction, is still one of the valuable inventions of the day, and is an exact reversal of the galvanic battery. The reversal is disclosed by stating that the operation of the primary or galvanic battery consisted in placing metal plates into a solution of salt or acid, and carrying off the electric current by a wire. The reverse of this consists in starting with an electric current, after the battery is partly exhausted, and passing the current through the solution in order to restore the chemicals to their original composition, ready to give off current as before the charging."

SLEEP.

Elizabeth Cady Stanton in an article describing her manner of living thus speaks of her ability to sleep and its healthful effects. "Someone, knowing my genius for sleep, says, 'You cannot be in health and sleep as you do on the slightest provocation.' "This, too, is an ancestral tendency. My grandfather made Sunday a day of rest. After feeding his cattle and taking a bird's eye view of his farm, he slept until dinner, and after a frugal repast, again until tea, and as soon as the sun went down he retired and slept all night. My father, conforming rather more to the demands of a progressive civilization, solaced himself with a few short naps; both at church and at home. He has been known, in our old Scotch Presbyterian church, to sleep standing all through the long prayer, and on a few occasions to maintain the perpendicular after all the congregation were seated, much to his own mortification and the amusement of his children. Yet as a judge and a lawyer he was always awake to the interests of his clients and the sophistries of the advocates in his court. He was the oldest judge that ever sat on a bench in this country, resigning at the age of eighty-four. When as a child I was disappointed in any anticipated pleasure, punished, or suffered injustice, I hurried to my room and went to sleep.

"In the palmy days of Theodore Parker's popularity, I attended his ministrations regularly. As it involved a long walk, and I reached his place of worship very tired, I made it a rule to sleep through all the preliminary services that I might be wide awake for the sermon, a friend near by arousing me at the right moment. Just so in going to a ball, party or dinner, I felt a short nap was an important factor in my toilet, as nothing could make me so attractive as the color and look of repose that follows sleep. No rouge or stimulus equal to it. If from no higher motive than vanity, I say to all girls in society, sleep. Cosmetics, laces and flowers cannot conceal a weary jaded look, nor a chronic condition of dissatisfaction. I have emphasized this point because most people seem to think that sleep is disreputable, that there is great virtue in being forever on the watch tower. This is one doctrine in the gospel of health that I have preached to nervous men and women in all my travels from Maine to Texas.

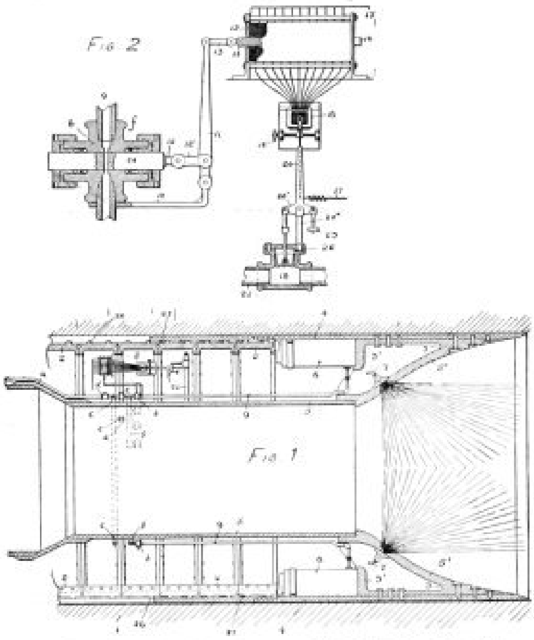
"Occasionally you will meet a crotchety man or woman who has some theory about early rising, and not satisfied to get up themselves to see the sun rise, they will waken a whole household, pulling young children out of their nests, making them cross all day. The insane asylums are full of people whose sweet morning slumbers have been rudely broken by some ignorant theorist. One of the most pitiful sights I recall in my Western travels was a breakfast table surrounded by children under ten years of age, eating bacon and buckwheat cakes by candle-light, the thin, nervous, tired mother during the day utilizing the time she had stolen from sleep in hemming half a dozen yards of ruffling for a pillow-sham. Seeing her continually yawning and stretching, I said, 'Why do you not lie down and take a nap?' 'Ah,' she replied, 'I have too much to do to waste an hour in sleeping.' "Why not dispense with the pillow shams and refresh the woman in view of her comparative importance in domestic life? is a question anyone of common sense would put to a mother under such circumstances."—*The Journal of Hygiene.*

WALKING BACKWARD CURE FOR HEADACHE.

An apostle of physical culture says that an excellent and never failing cure for nervous headache is the simple act of walking backward. Ten minutes is as long as is usually necessary to promenade. It sometimes, however, requires more than ten minutes to walk at all, if one is very "nervous" But it is not understood that it is necessary to walk a chalk-line. Any kind of walking will do, provided it is backward. It is well to get in a long, narrow room, where the windows are high, and walk very slowly, placing first the ball of the foot on the floor, and then the heel. Besides curing the headache, this exercise promotes a graceful carriage. A half hour's walk backward every day will do wonders toward producing a graceful gait.—*Medical Record.*

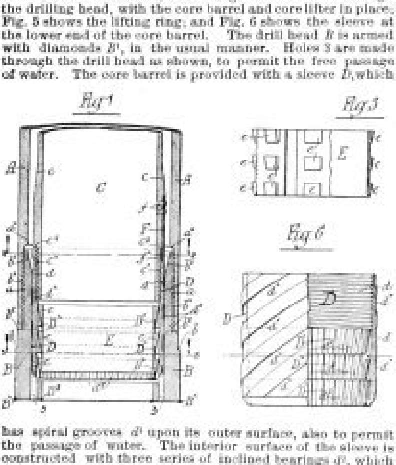
SHAFT SINKING APPARATUS.

No. 549,586. RICHARD P. ROTHWELL, NEW YORK, N. Y. *Patented Nov. 12th*, 1895. Fig. 1 is a lengthways section through the apparatus; and Fig. 2 is a detail of the governing apparatus, on a larger scale. In sinking shafts or driving tunnels in soft or wet ground, great difficulty is found in keeping the hole straight. When the head is forced forward it is apt to encounter softer earth on one side than on the other, and thus be deflected out of proper alignment. The apparatus here shown, is designed to govern the hydraulic jacks which force the head forward. Each jack 6, is supplied with pressure water through a pipe 9, and all these pipes are connected to a belt pipe c, by valves f. The mechanism of these valves, and the means of controlling them is shown in Fig. 2. The supply of water to any one jack, is varied by moving the balanced plunger 24. The valve lever is operated by an iron rod 14 which moves through a series of magnetic coils 15. The terminals of these coils are brought together in a switch board 16, and electric connections are made by means of a switch lever 20. A pipe 21, which extends around the inside of the head, is filled with mercury. Each switch lever is operated by the rise and fall of the mercury in a cell below the plunger 18, to which it is coupled. If the head 5 tilts out of plumb, or out of alignment, the pressure in the mercury cells varies accordingly. The shaft linings 2 are put in place, in sections, at the same time that the soft earth is being removed through the central tube 5, the space between the tubes 4 and 5 being sufficient to permit the workmen to operate. Several water jets 7 are arranged at convenient points, by which water may be projected with more or less force upon the earth in front of the head, to loosen it and assist its removal.



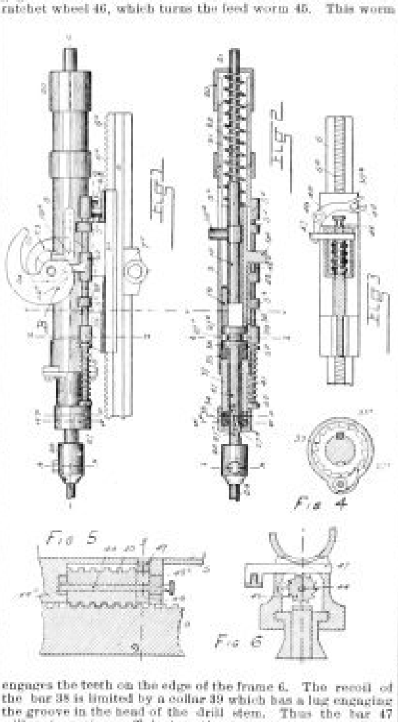
ROCK CORE DRILL.

No. 548,607. J. F. DUGGAN AND M. C. BULLOCK, CHICAGO, ILL. *Patented Oct. 22nd*, 1895. Fig. 1 is a section through the drilling head, with the core barrel and core lifter in place; Fig. 5 shows the lifting ring; and Fig. 6 shows the sleeve at the lower end of the core barrel. The drill head *B* is armed with diamonds B^1, in the usual manner. Holes 3 are made through the drill head as shown, to permit the free passage of water. The core barrel is provided with a sleeve *D*, which has spiral grooves d^1 upon its outer surface, also to permit the passage of water. The interior surface of the sleeve is constructed with three series of inclined bearings d^2, which engage corresponding bearings *e* upon the exterior surface of the ring *E*. This ring is split at one side, so as to contract easily, and is smooth upon its inside surface, so that a large surface is provided with which to grip the core. By making the bearings in three series, a sufficient amount of contraction of the ring is secured with a small upward movement of the core barrel *C* upon the gripping ring. The provisions made for the passage of water between the parts, adapt the drill to all varieties of work.



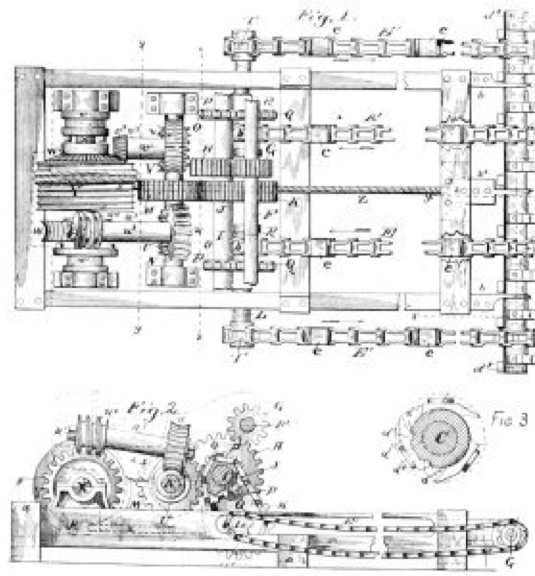
ROCK DRILL.

No. 548,324. HORACE B. MCCABE, LAKEWOOD, COLO. *Patented Oct. 22nd*, 1895. Fig. 1 is a side view of the machine; Fig. 2 is a section of the same; Fig. 3 is a partial view of the under side of the cylinder; Fig. 4. is a cross section at the line *W W* in Fig. 1; Fig. 5 is an enlarged section through the feed worm; and Fig. 6 is a cross section through the same on the line 9. This drill is worked by hand power, by means of a crank, which rotates the two cams 23 and 24. These cams engage the pins 18¹ and 19¹, which are attached to the hammer bars 18 and 19. The bar 19 is tubular, and the solid bar 18 plays inside of it. A spring 22 propels the hammer 19, and the bar 18 is thrown by the spring 21. The cap 20 can be adjusted, to vary the tension of the springs. The drill is held in the chuck 28. The stem 27 has two feathers, one spiral and one straight, which engage a pair of ratchets 33 and 34. The spiral feather operates to turn the drill stem at each forward movement. The feed is operated by the small cam *B* on the crank shaft, which moves the rod 38 by means of the finger 42. A pin 38¹ on the back end of the rod engages a lever 48 and works a tooth bar 47 across a small ratchet wheel 46, which turns the feed worm 45. This worm engages the teeth on the edge of the frame 6. The recoil of the bar 38 is limited by a collar 39 which has a lug engaging the groove in the head of the drill stem. Thus the bar 47 will not receive sufficient motion to engage a new tooth on the ratchet feed wheel, and turn it, until the drill stem has advanced within its casing nearly to its forward limit. The feed worm is supported on an eccentric spindle, and by turning the knob shown in Fig. 5, it can be lifted clear of the rack teeth, so that the drill may be freely drawn back.



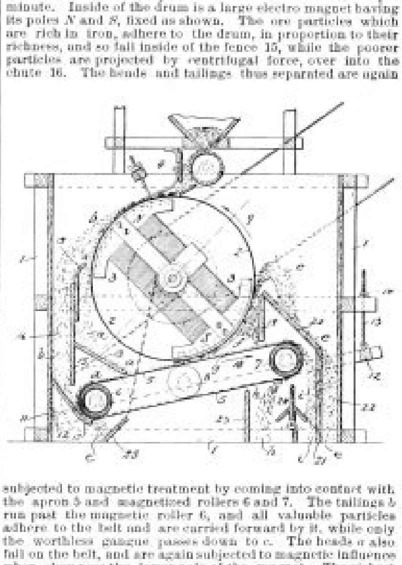
MINING MACHINE.

No. 548,760. BENJAMIN A. LEGG, COLUMBUS, O. *Patented Oct. 29th*, 1895. Fig. 1 is a top view of the machine; Fig. 2 is a side view of the same, and Fig. 3 is a section of the cutter bar. The chief novelty in this machine is in the cutter bar. The cutters are bolted to the outside of the cutter bar, as shown in Fig. 3. The bar is tubular and is made in four sections, which turn upon a fixed spindle *C*. This spindle is firmly held in three brackets b, b¹. Each section of the cutter bar is driven by an independent chain, the two middle sections revolving toward the left, and the outer ones toward the right. Thus, half of the cutters tend to lift the front end of the machine, and the others tend equally to depress it, consequently the machine is free from any tendency to "climb" or "dive." Each chain is armed with about four cutters, which make way in the coal for it. The outer chains are driven by the shaft *L*, which is geared to the engine shaft *F*, by means of the wheels *K*, *J*, *H* and *G*. The inner chains are driven by means of sprocket wheels *S*, which turn loosely on the shaft *L*, and are rotated by means of chains *P*, and sprockets *O*, on the shaft *I*. The machine is fed forward and back by means of a wire rope which engages the drum *Y*, and is fastened to each end of the stationary frame *A*. This drum is keyed to the shaft *X*, which is turned by means of the clutches *w*, *w*¹. One of these clutches can engage the worm wheel *W*, which is turned slowly by the worm *u*², shaft *u*¹, small worm wheel *u* and worm *U*. To reverse the feed and draw out quickly, the clutch *w*, is made to engage the bevel gear *W*′, which is driven by the pinion *v*¹, worm gear *v* and worm *V*. By making the rope a little slack, it will slip on the drum, when the cutters encounter anything unusually hard, and thus save the machine from breakage.



MAGNETIC ORE CONCENTRATOR.

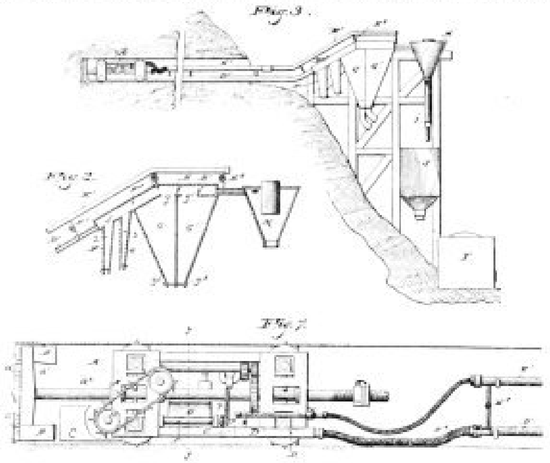
No. 548,176. CHARLES G. BUCHANAN, BROOKLYN, N. Y. *Patented Oct. 22nd*, 1895. The pulverized ore is fed through suitable feeding devices at 4, onto an iron drum 2, which revolves with a surface speed of about five hundred feet per minute. Inside of the drum is a large electro magnet having its poles *N* and *S*, fixed as shown. The ore particles which are rich in iron, adhere to the drum, in proportion to their richness, and so fall inside of the fence 15, while the poorer particles are projected by centrifugal force, over into the chute 16. The heads and tailings thus separated are again subjected to magnetic treatment by coming into contact with the apron 5 and magnetized rollers 6 and 7. The tailings *b* run past the magnetic roller 6, and all valuable particles adhere to the belt and are carried forward by it, while only the worthless gangue passes down to *c*. The heads *a* also fall on the belt, and are again subjected to magnetic influence when they pass the lower pole of the magnet. The richest particles adhere to the drum and are thrown upward over the fence 20, and pass away into the chute 22. The medium stuff strikes the plate 19 and falls back on the belt. The final separation is made by the magnetic roller 7, and the middlings



are delivered at h. The belt and rollers are mounted on a hinged frame, which permits the belt to be adjusted more or less closely to the drum 2 to suit varying qualities of ore. It is claimed that ordinary magnetites can be concentrated by this machine to sixty-eight per cent.

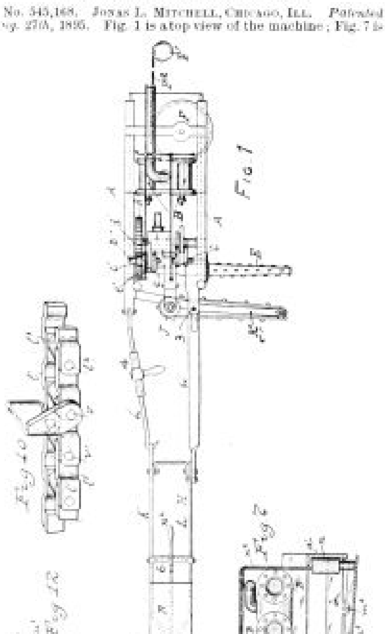
METHOD OF MINING COAL.

No. 550,031. Edward S. McKinlay, Denver, Colo. *Patented Nov. 19th*, 1895. Fig. 3 is a side elevation of the apparatus, showing the general arrangement; Fig. 2 is a detail of the separators; and Fig. 7 is a side view of the coal cutting machine. The machine employed is an ordinary "header" or tunneling machine, and it removes the coal in small pieces, as chips and dust. The cutter head is provided with two plates B, which scoop up all of the borings into the pan C. All of the large lumps are picked up by the conveyor N, and are thrown into crushing rolls P, which reduce them to fineness. The engines which drive the machine are driven by compressed air, and the exhaust is used with suitable jet nozzles to blow the fine coal, etc., into the end of a tube D, which is connected by a flexible pipe D^2, to a stationary delivery pipe D^3. At intervals along this pipe jets of compressed air are introduced by means of pipes E^1, from the air main E^1. The jets are pointed forward, so as to drive the pulverized coal toward the point of delivery. When the destination is reached the pipe D^3, is enlarged, as at F^1, in Fig. 2, and the stuff is shot upward over the mouths of the pockets 2 and 3. A separation of the good coal from the accompanying slate, etc., occurs at this point, because the coal being lightest flies over the pockets, while the heavier impurities which move more sluggishly drop into them. The coal is intercepted by the screens H, H^1, and is caught in the pockets G, G^1. The dust passes on into the dust catcher M. The coal passes by suitable pipes into the receiver J, from which it is fed into the coke ovens I. Slack coal, that is the material produced by this apparatus, is preferred by many manufacturers of coke, to lump coal, in fact they usually grind or pulverize their lump coal to a similar condition. This apparatus pulverizes the coal in getting it.



LONG WALL MINING MACHINE.

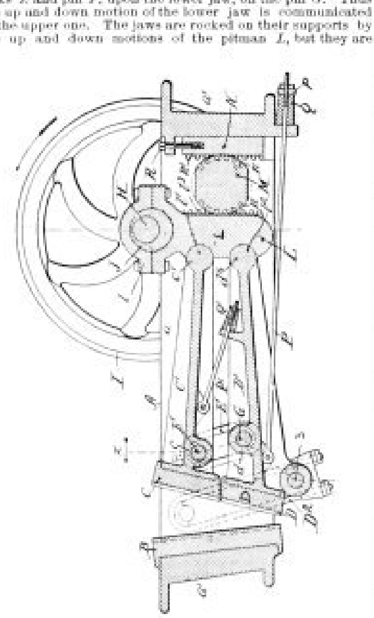
No. 545,168. Jonas L. Mitchell, Chicago, Ill. *Patented Aug. 27th*, 1895. Fig. 1 is a top view of the machine; Fig. 7 is a cross section at the rear of the engine cylinders; Fig. 10 shows the construction of the cleaning chain; and Fig. 12 shows one of the scrapers which are attached to the chain.



The cutter which is employed in this machine is a tapering spindle E which projects from the sides of the machine as shown, and is armed with numerous small cutting bits. Rotary motion is imparted to it by suitable gearing and an engine of which only the cylinders B are shown. The cutter bar is followed by a cleaning chain K, which removes the chips. The construction of this chain, and the scrapers attached to it is clearly shown in Figs. 10 and 12. The machine is propelled by means of a windlass F, which is rotated by the engine, and a rope F^1 which extends forward to a post F^2. The principal novelty in this machine is in the apparatus for steering. A long steering truck H is attached to the machine by a hinge at 3, and a right and left nut 4. The truck rests on two sharp edged wheels 5, which are made to bite into the floor by means of a large weight R. These wheels are steered by a tiller n^2 which can be secured in any hole in the bar 6. The final and and exact adjustment is made by working the nut 4. When at work, the cutter E tends to force the machine out of the cut, although the rope pulls at an angle tending to hold it in, but it can be held up to its work by setting the steering wheels 5 to lead inwards slightly toward the face of the coal. The angle given to the steering wheels depends upon the hardness of the coal or fire clay composing the floor, and the sharpness of the cutters. It may be varied while running, thus the operator is enabled to make a full depth cut throughout the entire travel of the machine. The forward part of the machine rests on a shoe or sled m^1, which is pivoted to the machine frame at m^2, see Fig. 7. Jacks n, n^1, which are worked by air pressure, serve to steady the machine and maintain a proper inclination of the cutter bar.

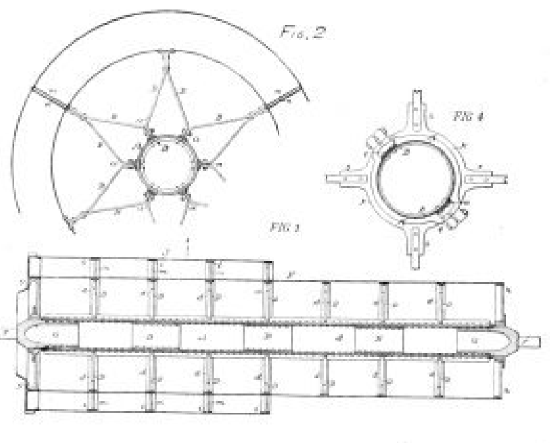
ORE CRUSHER.

No. 548,177. Morton G. Bunnell, Chicago, Ill. *Patented Oct. 22nd*, 1895. This machine has two moving jaws, which are operated simultaneously by the pitman L. The lower jaw D is suspended from the main frame by links D^2 and a pin 3, and is held in engagement with the pitman by the rod P and spring Q. The upper jaw C, is suspended by links E and pin F, upon the lower jaw, on the pin G. Thus the up and down motion of the lower jaw is communicated to the upper one. The jaws are rocked on their supports by the up and down motions of the pitman L, but they are moved forward and back in alternation by its sideways motion. The back of the pitman bar bears on a rolling fulcrum M, which has teeth engaging the pitman and the bearing block N, and moves up and down with it, though to only half the distance. Thus as the pitman is moved sideways by the eccentric J, one jaw is forced slightly forward while the other draws back. By shifting the block N, the bearing point of the fulcrum can be adjusted relatively to the bearings c^1, d^1, of the upper and lower jaws. The peculiar movements given to the jaws by this mechanism, are claimed to be very efficacious for the purpose of crushing stones and ore.



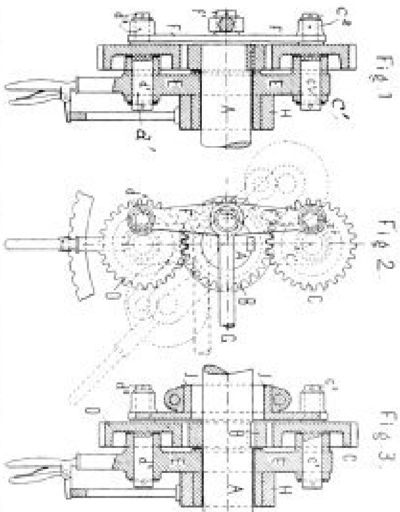
ROTARY SCREEN.

No. 549,365. Edwin H. Jones and Samuel Nicholson, Wilkes-Barre, Pa. *Patented Nov. 5th*, 1895. Fig. 1 is a lengthways section of the screen; Fig. 2 is a partial end view, on a larger scale; and Fig. 4 shows the manner of constructing the spiders. The shaft is made of plates which are rolled up into tubular form, and are joined at their edges by welt strips as in Fig. 4, or by T iron ribs as shown in Fig. 1. The several sections of the shaft are spliced and stiffened by means of internal tubes or thimbles B. In Figs. 1 and 2 a series of T ribs are riveted to the shaft; and the arms, which are made of flat iron, are riveted to these ribs. In Fig. 4 cast-iron spiders are employed, and these are made in halves and are clamped upon the shaft by bolts as shown. In this case the welt strips serve as keys to prevent the spiders from turning on the shaft.



VALVE GEAR.

No. 546,720. Kajetan Moscicki, Warsaw, Russia. *Patented Sept. 14th*, 1895. Fig. 2 is a side view of the mechanism; Fig. 1 is a vertical section of the same, and Fig. 3 shows a modification of the device. This mechanism is intended to take the place of the link motion for reversing an engine and for graduating the stroke of the valve to secure an early cut off of the steam. A gear wheel B is keyed to the engine shaft A. Two other gears C and D, which mesh into B, are supported on pins c^2, d^2, by the arm E. This arm can turn on a fixed bearing H, and it can be locked in any desired position by means of the latch and handle shown. Each gear C, D, carries a crank pin c^3, d^3, upon which a bar F, is suspended. The valve rod G, is attached to a pin at the middle of F. As the shaft and gear B revolve, the crank pins c^3, d^3,



and the pin to which the valve rod is attached, revolve in equal circles. In Fig. 3 the pin f' is replaced by an eccentric J, of sufficient size to permit the shaft to pass through it. The pin f', is shown at the left end of its stroke in Fig. 2. Now, when the parts are turned over to the position shown by the dotted lines, the gears C and D, turn on their spindles sufficiently to bring the pin to the lower quarter of its movement; if the arm be turned in the opposite direction, the pin can be moved to the upper quarter position, thus reversing the engine. If the arm is put in any intermediate position, the angular advance of the pin is correspondingly altered, and the motion of the valve, which is attached to it, is modified accordingly. For use on gas engines, which require the valve to be opened but once for each two revolutions, the gears C, D, are made of twice the diameter of B.

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METAL MINER.

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METAL MINING.

Ventilation by Natural Draft and by Assisted Draft.

Importance of Ventilation in Metal Mines Less Than in Collieries, but Too Often Overlooked—Sources of Vitiation of Mine Air—Special Need of Studying and Utilizing Natural Draft—Working Rules and Practical Suggestions for Controlling Air Currents Underground.

Written for THE COLLIERY ENGINEER AND METAL MINER by Albert Williams, Jr., E. M.

The ventilation of metal mines presents by no means the same difficulties as that of gaseous collieries, since as a general rule all that is needed is to supply enough fresh air for the health, comfort and effective work of the men and to remove the dead air vitiated by their respiration, by burning of candles or lamps, and by powder fumes. Usually there is no need for the additional and large volumes which have to be had in coal mines to carry off fire damp, choke damp, etc. Yet it is evident that, so far as it goes, there is always absolute need of sufficient ventilation; while also there are special cases requiring almost as careful attention as in collieries. However to simplify the matter at once, it may be said that it is very seldom indeed that mathematical computations and refined measurements of volumes, velocities and pressures would be called for, and that for all practical purposes the senses may be depended upon as guides. The exceptions requiring close calculation are so few, that for present purposes the student may be referred to treatises on colliery ventilation for data of this order.

The plain and simple rule is to be always sure that there is a liberal surplus of fresh air. It needs no testing apparatus to discover when the supply falls short.

CAUSES OF AIR VITIATION.

Respiration of the Men.—This is an ever-present source of air deterioration—both by the absorption of oxygen and the production of carbonic acid gas, perhaps still more by exhalation of organic gases. In a confined space, as in a small heading, the top of a raise or bottom of a shaft or winze, the lungs of two, four or more actively working miners would soon render the place untenable, unless there were some movement and replacement of air. Figures used as a basis for computing the number of cubic feet required per man in a given time, as in arranging for ventilation of halls, schools and theatres, are wholly useless here, for it is evident that the requirements per man must be indefinitely greater.

Respiration of Draft Animals.—Animal traction is very seldom used in American mines of any sort, and in metal mines only in large tunnels, assumed to be naturally ventilated. If horses and mules were used underground on closed levels they would, of course, make large demands upon the air supply.

Combustion of Candles or Lamps.—The amount of carbonic acid gas produced in this way may be four times as much as that exhaled in breathing. This is seldom realized. But the injurious effect does not appear to be in like proportion, for the oil, tallow, etc., give off only this one gas and no other poisonous products. The substitution of electric incandescent lights in the working places eliminates this trouble, and the question of non-fouling of the air is not the least of the arguments for the use of electric lights in metal mines.

Animal Filth.—There should be strict prohibition against befouling the workings. This is not simply a matter of decency and comfort, but also of hygiene.

Effect of Explosives.—The foul air produced by explosives is a more serious matter, though intermittent. After every blast, a certain time must be allowed for the gases to drift away and be slowly diffused, and this time can be shortened by strong artificial ventilation. So far as possible the shots should be fired at the end of shift, when less time is thus lost; and in some kinds of work, as in advancing a drift in country rock, the shift may just suffice for drilling all the holes, after which they are charged and fired in two blasts. But this convenient arrangement does not hold in stoping and in the majority of operations; so that in an active mine, blasts are being fired somewhere at frequent intervals. Hence special provision must be made or there will be undue loss of time.

Black blasting powder is one of the least objectionable explosives in this respect, but it is very rarely used under ground now. Its fume consists of sulphide and carbonate of potash, with a mixture of gases—carbonic acid, carbonic oxide, nitrogen, sulphureted hydrogen, marsh gas and hydrogen—but the more poisonous gases are in relatively small proportion. Giant powder (dynamite) and the whole family of nitro-glycerine explosives produce a variety of gases, together with the dust of the absorbent. There certainly is a considerable difference in the effect of their fumes, and while the advocates of each of the dozens of kinds of explosives of this class will admit that all the others are deleterious, they claim special inoffensiveness for their own make. The truth is that none are unobjectionable. It makes a great difference, too, whether the high explosives are completely detonated, as to the proportion of the resultant gases, and it has been remarked that a poorly exploded cartridge gives worse fumes, besides being a failure mechanically. What applies to nitro-glycerine explosives (dynamite) applies also to other nitro compounds—nitro-cotton, nitro-benzene, and the long list of new high explosives—though over each of these too there is an unsettled dispute. In American metal mining comparatively few of these explosives are used in any quantity, and the selection is generally determined on other considerations than that of fumes. If, however, the products of combustion of any particular brand are found to be more noxious, or less so, than the average, due weight should certainly be given.

Some persons are much more sensitive than others to the fumes from the high explosives; while there are others who are affected by emanations from the nitro-glycerine, etc., on opening a cartridge to insert the cap. The effects are nausea and dizziness, for which plenty of fresh air is the best remedy.

Mr. C. LeNeve Foster quotes the estimate of Dr. Angus Smith, who finds that "two men working eight hours and using half a pound of candles and 12 ounces of gunpowder, produce 25.4 cubic feet of carbonic acid (at 70°F), 10.3 by breathing, 12.3 by candles, and 2.7 by gunpowder." This is cited here to show that, with a low consumption of candles and powder (and the weights for both are disproportionately small for ordinary working conditions in metal mines), the breathing of the men is not the chief source of air impairment. The substitution of a high explosive for the black powder, as is almost invariably done, does not alter the general bearing of the case, at least not for the better.

The three agencies just referred to—respiration, burning of illuminants, and products evolved in blasting—are usually the only, or the main things to be considered, and all others may be regarded as exceptional. The former are introduced into the mine artificially, in the course of working it; the latter are mainly due to natural causes existing in the mine itself. There are however, still some subsidiary artificial effects, as for example—

Dust.—Metal mines are more likely to be very wet than too dry, but there are some that are very dry. Dust is made by the handling of broken rock and ore, by the shattering effect of the blasts, and in overhead drilling, or all drilling whether by hand or power, when water is not constantly supplied to the holes. This fine sharp dust may be present in thick clouds in confined spaces, and is highly injurious to the lungs, even if not actually poisonous chemically. Its removal is another call upon the ventilating facilities of the mine.

The dust of mines may be actively poisonous, as that found in lead carbonate ores, arsenical and antimonial gold and silver ores, cinnabar, etc.; good ventilation would be a partial, though not alone a complete, preventive against "leading," salivation, etc.

The upper levels of a mine not originally dry may become so, if there is very thorough drainage in the lower levels, and thus dust may be formed in a mine not naturally a dry one.

Vapor From Exhaust Steam.—This is rather an inconvenience than anything more serious. If there is machinery underground run directly by steam, there may be not only the puffs from the exhaust of the non-condensing engines (pumps, baby hoists, etc.) but leakages of steam pipes and connections. A good draft is needed to clear away the clouds of vapor that may be formed.

Decay of Timbers.—This is so rapid in some mines as to have considerable effect upon the purity of the air. It is not only an oxidizing process, with evolution of carbonic acid, but a putrefying one resulting in the emanation of various noxious gases—a dry rot. The stripping of bark from round timbers to be used as supports underground is thought by some to delay this action.

Heat From Underground Steam Engines and Pipes.—This is sometimes so great as to be very oppressive, and is dangerous also as a possible cause of fire. It cannot be avoided altogether, if steam machinery is still to be used underground; but it can be much mitigated by a plentiful flow of cool air from the surface through the heated places.

Among the detriments to the underground air, due to conditions inherent in the mine itself and not brought in artificially, are explosive gases and poisonous emanations from the ground as it is opened out. These, as already stated, occur comparatively rarely, though there are enough cases on record to make a formidable list when they are all brought together. There is also the question of natural temperature, as related to and modified by ventilation.

Explosive Gases.—Marsh gas (the principal constituent of the fire damp of collieries) is the most important of these. It is derived from decomposing carbonaceous matter (not necessarily coal), and may accumulate in the interstices of the rocks, and subsequently in the mine openings, in sufficient quantity to produce an explosion when ignited. It would not ordinarily be expected or provided against, and there have been a few bad explosions caused by it. It has been noticed most frequently in lead mines, in limestone and in black band iron mines (where also there may be seams of coal). Sulphureted, phosphoreted and arseniureted hydrogen, and simple hydrogen form explosive mixtures with the oxygen of the air, but rarely accumulate in sufficient quantity to be dangerous.

Poisonous Gases.—Carbonic acid gas may exist naturally in ground worked for metalliferous ores, and there have been a few notable instances of its presence in considerable quantities. It would be reasonable to expect it to be found in mines of black band iron ore having also coal seams, and it has been so found; but mines of this character are not worked in the United States. It is also found native in some lead and zinc mines, and indeed might occur wherever carbonaceous matter is present and is being completely oxidized, and under certain conditions may be formed by the decomposition of limestone and other carbonates (ores or rocks) by acid waters or heat.

The hydrogen compounds with sulphur, phosphorus, arsenic, etc., are highly poisonous, and cannot be tolerated in any large proportion in the air mixture. They are readily detected by the various disagreeable odors, however. This is also true of sulphurous acid, resulting from decomposition of pyritic minerals.

Nitrogen (negative, not poisonous) and some other gases are occasionally given off in small quantities from rock and ore.

As a mine is opened and drained, and the active oxidizing action of the air comes into play, while the course of chemically charged waters is altered, there is every opportunity for a variety of reactions to occur between the constituents of the ore and rock minerals, the gases and the waters; and it is not extraordinary that sometimes these reactions result in the formation of products injurious to respiration. While the really serious cases are not very frequent, the possibility of trouble is not to be lost sight of.

Natural Underground Temperatures.—Below the shallow depth (a few feet only) where atmospheric and surface changes cease to have influence, there is in the undisturbed rock a gain in temperature with increase in depth. This gain is more or less rapid according to locality and a variety of conditions. It is of no interest here to attempt to average the observations, for the range is so wide that for any particular mine the rate might be very far from any arbitrary average. The older authorities stated the "average" at about 1° F. for every 55 feet of descent. Later observations show the increase to be generally much less rapid, and 1° to 70 feet would now be considered a sharp rise. There are plenty of cases where the advance is only 1° in 100 feet or more; while on the other hand there are some instances in which a considerably faster gain than the formerly assumed average or mean has been noticed. Moreover, the increment is not even constant for the same mine, and it is quite likely that there are spots in which for a space the temperature change is actually reversed, a cooler zone existing below one heated by a lateral and local flow of hot water, since it is well known that rock temperatures are largely affected by those of the percolating waters. An ore-bearing region is not the proper place to discover the law of heat increase with depth, some such regions having stores of residual heat from volcanic eruptions and earth movements, while many others still feel the effects of solfataric action, with frequent hot springs in the neighborhood. Probably metal mines (excepting those of bog and lake formed deposits) as a general thing are in ground that with depth grows hotter than the true normal rate (if there is one) for the earth at large.

The essential point is that the rock is naturally hotter as we go down, and in most very deep mines (say from 2,000 to 4,000 feet) this increased heat is a great drawback. Ultimately it will put a limit to all mining, apart from the lesser mechanical difficulties. At present it is safe to look forward to working at a depth of at least 6,000 feet, probably more, so far as heat is concerned, in the cooler districts. Men have already mined with a rock and water temperature of 150°, provided the fresh air supply was abundant. In extreme cases the intake pipes have been discharged through ice water. [Consolidated Virginia (Nevada) used $15,000 worth of ice in one year.]

It is found that though, after reaching a certain depth in sinking, the rock at the bottom of the mine is always hot and growing hotter, the upper levels after being opened and properly connected by means of winzes, and a copious volume of fresh air constantly passed through, become cooler. The cooling effect of the air upon the rock is slow, as there is so large a store of heat, rock so poor a conductor, and only the small exposed surface to act upon. It is possible to have a lower level cooler than an upper one in time, by giving it better ventilation, as can be managed by suitable arrangements.

For immediate purposes, however, what concerns the miner is not so much the temperature of the rock and water, as the coolness, freshness and volume of the circulating air. After starting a level it is out of the question to wait for it to cool off before advancing and fully developing it. Later, it is so much the better that a main gangway, possibly to be used for several years, is becoming cooler. At the moment, what is wanted is effective ventilation.

The increasing heat of deep mines has another relation to ventilation. With the mine connections in suitable shape, this heat acts like that of an artificial furnace in causing an upward current, and therefore a corresponding downward intake to replace it. Whether or not there is artificial ventilation besides, this is of great importance.

The temperature of shallow mines, if not raised artificially, is cooler in summer than that of the surface, and warmer than the surface in cold weather. Usually it is only at considerable depth that the rock temperature is hotter than that of the surface all the year round. As in the mountain regions (where the greater number of metal mines are) there is a marked change in surface temperature from day to night, it often happens that there may be a daily alternation in relative surface and underground temperatures in mines of small depth. These facts have a controlling influence upon natural ventilation, and an important bearing upon artificial ventilation.

NATURAL VENTILATION.

In the great majority of metal mines this is the sole reliance. It is usually sufficient, and in very small mines is often allowed to take care of itself, although the adoption of simple and cheap arrangements for controlling natural currents would greatly improve conditions. As the workings are extended, the connections made for development of ground or convenience of handling ore, waste and water serve also for ventilating; but if these connections are planned with a view to the most effective ventilation as well as for the other purposes, the result is much better, and there is generally but little additional expense. In mines having a plant of surface machinery for hoisting and pumping, power drills driven by compressed air are commonly used, except in the few cases where the ground is mostly "picking," and then the exhaust from the drills usually suffices for ample ventilation. Even when starting a mine in hard rock, without knowing in advance to what extent the workings are to be carried, a small compressor plant is sometimes set up, so that driving by air drills may expedite development.

But if natural ventilation is of more importance to the metal miner than to the collier, it is also requisite for the former to understand it thoroughly and pay more attention to it, so that it will operate to the best advantage. It is always desirable to avoid putting in fans or blowers and their connecting pipes unless this becomes absolutely imperative; and this is all the more true in the case of a mine which has no other machinery.

General Principles.—The theory of natural ventilation is simplicity itself.

1. Air heated above the temperature of the atmosphere at a given level has a tendency to rise, because expanded and therefore lighter. Cooler air sinks, for the opposite reason.

2. Diffusion is the tendency of two or more gases of different densities, but originally of like temperatures, to become uniformly admixed without regard to the difference in weight.

3. Convection is the tendency of currents of different temperatures to seek an equilibrium, and in the circulation thus produced an approach to uniformity of temperature within a closed space.

The first principle explains the movement of main trunk currents in a mine. Diffusion and convection together explain why powder smoke and foul air, in the absence of appreciable ventilating currents, slowly become diluted through the mine air, so that, while the whole body of air is deteriorated, that at the place where the blast was fired or the foul air produced becomes in time diluted enough to be respirable.

Simple Tests.—The direction of air currents, not otherwise perceptible, in horizontal workings may be ascertained by observing the flame of a candle held very steadily and not breathed upon. In a drift the candle should first be placed on the floor (to test the lower current), and then held or fixed near the roof (to test the upper current).

The velocity of a current can be found by burning a pinch of powder at one point, a second observer at, say, 100 feet away, timing the interval required for the odor to reach him. If there is any current worth considering, the time will be less than that required for mere diffusion. The time required for the fumes from a blast to reach a given point also gives indications.

The following are some common and simple cases of natural ventilation:

Unconnected Workings.—It might be thought that here is no chance for ventilation. But so small are the differences in conditions required to set up a current that wherever work is going on the air is never absolutely dead.

At the heading of a tunnel the air is heated by the burning of candles and the animal heat of the men. This air rises to the roof, drawing in cooler air at the bottom to replace it, and if the tunnel is not too long there will be a gentle outward flow along the roof to the tunnel mouth, and an inward flow along the floor. This for a certain distance may suffice. When a shot is fired the hot gases from the blast have a similar, but intensified effect, as may be seen by noticing that the smoke follows the roof outward. If, however, the up-grade of the tunnel places the heading too far above the mouth, this movement is checked or altogether stopped, and the air at the face becomes permanently bad, requiring artificial or assisted ventilation.

Similar conditions hold as to inclines.

In a vertical shaft the dripping of water down the sides may cause downward exterior currents, with a compensating upcast centrally, or there may be a difference between one side and another.

Single Tunnel Connected with Single Shaft.—If the air at or near the junction is warmer than the exterior atmosphere, it will rise through the shaft, making it an upcast, and cooler air will enter the tunnel to replace it. If the depth and horizontal distance are moderate the course of the air may be reversed by the weather, by season, or change from day to night. When the air in the mine is cooler than that of the exterior atmosphere, as on a hot summer day, the shaft becomes a downcast.

Two Tunnels Connected by a Winze.—If the air within the mine is warmer than without, the inflow will be through the lower tunnel, up the winze, and out of the upper tunnel. If cooler, the reverse.

With more than one connecting winze, the general course will be the same, but the air (following the direction of the least resistance) will favor one winze rather than the other or others, even sometimes to the extent of rendering the latter practically useless for ventilation.

If there are several tunnels at different levels, with several connecting winzes, the same general principle holds good; but of course the circulation will not be uniform throughout, the air again taking the easiest course.

Straightness and smoothness of course have a selective effect upon air currents, as against crookedness and irregularity. If the temperature differences are very slight they may be offset in this way.

Two Shafts Connected by One or More Levels.—Which shaft will be the downcast and which the upcast will depend on the relative weights of the respective columns of air they contain. The problem is somewhat complicated by having three elements to be balanced against each other: (1) relation of mine air temperature to exterior temperature, plus or minus; (2 and 3) depth of each shaft. Where these differences are slight, it is not easy to predict which way the current will go, and it may fluctuate. When a current is once set up it has a tendency to continue in the same direction; and, if reversed, to go on in the new direction. Thus after a fire in a mine opened by two shafts and connecting levels, the current was permanently reversed. In this case the conditions were so nearly balanced that the accidental change could not be overcome. The direction may also vary with change of season, sometimes from day to night even, or according to the wind.

Evidently, other things being equal, the lighter column will be a rising one, or (what is the same thing) the heavier will fall. If the mouths of the two shafts are at considerably different altitudes, the case resembles that of a mine with one tunnel connecting with one shaft; that is, if the interior air is hotter than the outer atmosphere, it will rise through the taller shaft, making that the upcast, and *vice versa*. Yet, although the elementary principles of ventilation are so simple, the influence of small counter-acting conditions (to which no numerical factor can be assigned) often produces unexpected and puzzling results. Thus the engineer who has planned connections with a view to having the shaft in which the men are hoisted and lowered the downcast, and the other (the "air" shaft) the upcast, may be disappointed in his calculations, unless the differences in conditions are so marked as to be unmistakable. This does not argue ignorance of the laws of physics, or signify that there is any mystery about the principles, but only that in a problem of much delicacy the necessary data are not obtainable with precision. This difficulty, instead of discouraging the projector, should stimulate him to make the most careful observations and inferences before planning new connections for ventilation.

In most instances it does not make very much difference which way the current moves, provided the volume and velocity are sufficient. It is desirable, however, if possible, that a working shaft should be a downcast, so that the men entering and leaving the mine may have fresh air, while an idle shaft may be the upcast for removal of vitiated and heated air and vapor. It is also desirable that the fresh outer air should be led as directly as possible to the working places, leaving the mine air to find its way out through unused workings.

Some large metal mines have several shafts or tunnels connected on many levels. To direct the currents to the best advantage it may then become necessary to resort to some of the expedients explained beyond or introduce artificial ventilation, for with a multiplicity of passages the currents are very prone to short circuiting.

Disturbing Influences.—The wind has already been mentioned. It will readily be understood that a high wind striking in at the mouth of a tunnel, or deflected by a hillside or buildings down a shaft, may cause the mine air current to be reversed, like the draft of a smoky chimney under similar circumstances.

Unusual heat from underground steam pipes and engines, the combustion of illuminants, the heated gases of blasts, and animal heat, cause local disturbances of temperature which generally assist ventilation (so far as mere circulation is concerned), though in rare cases it is conceivable that they may retard it, while of course they impair the quality of the air.

The movement of cages, cars, pump rods, balance bobs, etc., and of rock in chutes, also has on the whole a beneficial effect, though a stationary cage or car may temporarily block circulation.

"ASSISTED" NATURAL VENTILATION.

There are several ways in which natural ventilation may be accelerated and properly distributed, without much expense or trouble, to meet moderate requirements not calling for the setting of special blowing or suction plant. The most obvious is to separate counter currents or moving air from dead air, thus giving them a clear passage instead of letting them be retarded and become mixed with air that actively or passively opposes them.

Sollars.—These are horizontal partitions in drifts and along main galleries, by which the heated air from the working face is led out to the tunnel mouth or discharged into an upcast shaft. They are made of lagging or boards, and are placed rather close to the roof. They assist the air movement, but have great offsetting disadvantages, so that they are very seldom used in metal mines: (1) In order to allow head room in the gallery, the excavation must be a foot or so higher than it would otherwise be, at considerable expense for labor, explosives and for the additional length of props; (2) they are awkward to set up and to advance; and (3) the introduction of any woodwork besides that actually needed as timber supports, and especially woodwork of this light and inflammable character in such an exposed position, is to be avoided on account of the danger of fire. The wood has every opportunity for drying out and would become ignited on small provocation.

There are also bottom sollars, along the floor of a gallery. If constructed for the sake of ventilation alone they would be equally objectionable; but when a water drain is cut in the floor and planked over, it would be well enough to allow a little extra space for the passage of air—which, however, would usually have to contend with an opposing water flow and thus move sluggishly.

Brattices—Are vertical partitions extending along and near one side of a gallery, or (if the latter is very wide) through the center, cutting it then into two roadways, one an intake and the other an outlet air passage. They are made of boards, brattice cloth or old canvas, and to prevent the canvas or cloth from rotting it is tarred. This makes another very dangerous fire risk, added to which is the large amount of extra space required. Brattices are not in favor in metal mines.

Wooden Air Boxes, in continuous lengths are sometimes used, and are much preferable to sollars and brattices. They are roughly made and do not need to be anything like air-tight. The usual practice is to place them in one of the upper corners of a gallery, or, more rarely, in the water drain. They add to the fire risk, but less so than sollars.

Metal Pipes of thin sheet iron, old tinned roofing iron, etc., are much better. They can be round or rectangular in section.

Large Canvas Hose.—A cheap air conductor can be extemporized with old canvas or any cheap fabric. The objection to both metal pipes and canvas hose is that, with natural ventilation alone, their cross section is too small to carry a sufficient volume of air, unless the natural draft is unusually strong. The canvas pipes have the advantage of being very readily moved about as required; and both the wooden boxes and metallic pipes can be placed and removed with little trouble also.

Air Doors.—These are very seldom seen in metal mines, though there are many situations where they would be of great assistance, as where the current short-circuits and refuses to pass through the working places, taking the easier cut. Air doors may be made of boards or planks, fitting close to a frame or the timber supports, hinged, and self-closing. A simpler arrangement is to hang a loose sheet of canvas (of the same size as the gallery section) to a cap or a special scantling. Passing cars then push under it, after which it falls back into position.

LINED SHAFT COMPARTMENTS.

Unless there is special reason otherwise, the two, three and four-compartment shafts of metal mines are left with open frames between the compartments. This is for safety in the case of cage accidents of some kinds, and for convenience in getting at the pump compartment from a hoisting one. But, if advisable, the compartments may be partitioned off by lining (with boards or planks, usually set vertically with butt joints), so that a single shaft may serve both as an upcast and a downcast—though by no means so well as two separate shafts. Air doors would generally be needed at stations and especially at the bottom level.

Chimneys.—If an air shaft (upcast) does not draw well, and it would not interfere with any other use to be made of the shaft, a cheap chimney of some sort can be built or placed on its collar and carried up to the necessary height, which need not be very much.

Housed Shafts.—When the hoisting and pumping machinery are placed in a house built to cover the shaft, head frame, sheaves, etc., (as is the custom at Western mines, on account, mainly, of the severe winters), the mine ventilation should not be overlooked. If the shaft is an upcast, over it should be an open, but hooded, belfry or cupola-like structure, to allow free escape of mine air and vapor. If a downcast, the air admitted should be fresh and free from the dust made in the surface handling of ore and waste.

Windsails.—Fresh air may be forced to the bottom of shafts of moderate depth, by setting up a funnel-shaped canvas ventilator, which can be turned to face the wind, and connecting it with the shaft bottom by means of a large canvass hose or any sort of pipe that is large enough. This is a simple and convenient make-shift for use while sinking uncovered shafts to 100 or 200 feet in depth.

Bailing Foul Air.—As in well digging, it is occasionally possible to partially get rid of the heavy bad air (charged with CO_2) which may collect in the sump and near the bottom of a small shaft, by bailing it out. This can be done, in an imperfect but practicable way, by extemporizing a dipping apparatus in the shape of an inverted umbrella, lowering it down gently and raising slowly, repeating the operation a number of times.

The Exhaust from Air Drills.—This is the most important agency for ventilating mines short of putting special machinery for the purpose. Indeed, where many power drills run by compressed air are in use, they do away with the necessity for blowers and fans, except in very extreme cases.

Although the drill pipe is so small, it carries a great deal of air (as measured by its expanded volume at atmospheric pressure.) The delivery at the drills is 70 lbs. or so, and when released and expanding the exhaust has the additional great advantage of largely reducing the temperature, which is ordinarily too high at the working face. This air is delivered precisely at the place where most needed, and a better effect is produced than by any suction fan arrangement. Again, there is no shifting of ventilating pipes, boxes, etc., as the work progresses. All of these points are of high importance, especially when driving very long galleries.

ADVANTAGES AND DISADVANTAGES OF NATURAL VENTILATION.

Wherever it is practicable to get along without the use of blowing or suction machinery the metal miner will inevitably do so.

Natural ventilation has these advantages: (1) It costs nothing, after the connections are once made; (2) it takes care of itself, for the most part. And it has these disadvantages: (1) It is often insufficient; (2) it is not always reliable, fluctuating with the weather, the time of day, the wind, and artificial disturbing causes; (3) while it costs nothing for maintenance, it may require a considerable initial outlay in making connections or sinking (or raising) air shafts which would not be otherwise needed. As against this latter point, it may be remarked that most of the work in developing fits in with that done to gain air connections, and *vice versa.*

All metal mines are started on the basis of natural ventilation. When that becomes unsatisfactory, the various "assisting" expedients come into play. Finally, if there is no other course, the management will have to turn to means of artificial ventilation. (These will be considered under a separate heading.)

(To be continued.)

THE GARLOCK PACKING CO., of Palmyra, N. Y., with branch offices in the cities of New York, Boston, Chicago, Philadelphia, Pittsburg, Omaha, St. Paul and Rome, Ga., report that their business for the year 1895 was the most prosperous in the history of the company. Their Sectional Ring, Elastic Ring, Spiral and Special Water Packings are not only holding their own but are becoming more popular year after year and are coming into general favor with engineers of all sections of the country. Their new Water Proof Hydraulic Packing is especially adapted for high pressure pumps, hydraulic machines and pumping stations. They have recently placed in the market a high pressure packing intended for high pressure work on locomotive, stationary and marine engines, which is designed and made to insure long services. Engineers who are unfamiliar with the products of the Garlock Packing Co., and are using cheap, inferior packings, would do well to investigate. Samples, catalogues, and prices can be obtained by addressing the nearest office.

COAL MINING IN WASHINGTON.

The Coal Resources of the State and Their Stage of Development.

A Paper Read at a Meeting of the Washington State Immigration Assocation, by Mr. T. B. Corey, Late Superintendent of the Oregon Improvement Co.'s Mines.

In writing an article on this subject, I find that the time given me is so limited that I shall be compelled to draw largely from a former paper written by myself and published some three years ago in the *Illinois Mining Institute Journal.* It would be a very difficult task to go into a detailed statement of the various coals found in this State, owing to the diversified condition of the coal beds; in fact, I doubt very much if there is any state in the Union where there is such a variety of coal. There has already been found coal from the lowest grade of lignite to the highest grade of anthracite. As yet, the coal industry of this state is only in its infancy. Hardly a month passes but what new discoveries are made, and some of them considered valuable. Most of the discoveries so far have been made by accident rather than by any preconceived plan of prospecting.

Commencing at the western portion of the state, the veins as exposed show hardly anything but woody matter; but, as we go east to the Cascade mountains, the coal increases in richness until we find a very good quality of anthracite.

It is also true as we approach the Cascades the strata are more irregular, in fact, in the bituminous districts there seems to be no regularity whatever, but the strata being more or less broken up with anticlinals and synclinals. East of the mountains the veins run a great deal more regularly and the angle of the dip is not so great.

Commencing at the northwestern part of the state, there are three or four seams of high grade bituminous coal and a few lignite seams. The coal measures are all underlain with clay schists and metamorphic slates, and this fact shows that they are in an upheaval; the coal measures, consequently, are in a very disturbed condition. The coal does not run regularly, but what is known as "pockety"; that is, the seams pinch to nothing or thicken to abnormal size. The seam nearest the schists, which is sometimes only two or three feet from them, is richest in carbon and lowest in moisture, the higher ones gradually losing carbon as they recede from the schists, and those on the Skagit river yield a coke equal to any made in the United States.

This coal district is in the region of Skagit river, Lake Whatcom and Nooksack river and extends almost to the Canadian line. The dips are from 50 degrees to vertical. Around Lake Whatcom to the northwest, Skagit river, southwest, and at Nooksack river the dip is very changeable, although in general terms it may be said to be north or south, depending on which slope of the great anticlinal and synclinal folds the seams are exposed. The area of this section is about 300 square miles. The coal around Hamilton, on the Skagit river, is very rich in carbon. There are four distinct seams, dipping at an angle of about 45 degrees. There are also here large seams of iron ore which are exposed to view on the Skagit river. For miles south of this there are strong indications of coal, and some very good veins have already been discovered. Around Hamilton the coal seams are more regular than in any part of the field in the northwestern part of the state. At Jennings, which is west of Hamilton, are two or more seams of coal. Quite a number of coke ovens have been erected, about one-third of the output being made into coke, and an excellent coke it makes, too, which, as I have before stated, is equal to any in the United States. This coke, being so near the iron ore, will be accessible for smelting iron. The coal veins run from thirty feet to one foot in thickness and dip at various angles. North and west of Jennings is the Blue Canyon coal mine, which is located on the eastern shore of Lake Whatcom. The vein varies from twenty feet to one foot, and has not the coking qualities of the Skagit coal, but is a good gas coal; it dips northwest 30 degrees. The seam rests on the clay slates, which are soft and swell, causing considerable trouble in mining.

The company operating at this place has expended large sums of money in erecting bunkers and building a large boat to transfer railroad cars across the lake, at the foot of the mountain, to a railroad which carries the coal to New Whatcom. From thence it is conveyed to the coast towns by ships. New Whatcom is located on Bellingham bay. Near this bay the first coal in this state was discovered and mined for the Hudson Bay Company's steamers some forty years ago. The vein is from ten to twelve feet in thickness, and is found in the upper measures of the Cretaceous; it is a lignite, and is not underlain by metamorphic slates. It dips to the northwest. On the west side of Lake Whatcom there are several small seams of coal, but not in sufficient quantities to make them workable. South of this is Chuckanut bay, where the coal measures crop out for miles, showing an enormous thickness, but no veins as yet have been discovered which are considered to be of any value. The measures end abruptly in the northwest corner of Skagit county. Going north of New Whatcom the country is flat, and consequently no exposures are to be seen. The coal on the Nooksack river is all high grade, but the seams are thin. The productive part of this field is nearly all on the eastern range, or nearest to the mountains. All through almost the entire northwestern part of Skagit county the country is very mountainous and broken, and is densely covered with timber, fir, cedar and hemlock—the finest in the world.

Farther west, near Port Townsend, coal measures are to be seen, and several small seams of coal, but as yet nothing to justify starting a plant.

In Snohomish county there have been several veins discovered, but from the best information I have, no developments have been made to justify an opinion as to their worth.

Next is King county, which is the largest and most developed coal field in the state. There are two classes of coal in this county, one a high grade of lignite, which has an area of about 120 square miles; the other a bituminous, which covers about 300 square miles. They no doubt belong to the Cretaceous epoch, the lignites being in the upper, and the bituminous being in the lower, the bituminous coal lying in closer proximity to igneous agencies, which by their heat and pressure have driven off volatile gases and moisture, resulting in a higher grade of coal. For this reason the quality of bituminous coal is improved as it approaches the mountains, and is often of strong coking quality, but the regularity of the seam is destroyed. The lignites of this county must not be confounded with the lignites of the Tertiaries found farther to the south, from which they differ as materially as oak does from cottonwood for heating purposes. These lignites have great heating qualities, while those of the Tertiaries are not much better than "brown coal." The general dip of the lignite seams is apparently to the north, then again a little west of north, while in the bituminous district there seems to be no regularity whatever; but the strata are more or less broken up with anticlinals and synclinals, and in this part of the field, as they run into or approach the mountains, they become very much distorted; but the coal becomes much richer (in some cases almost coke), yet so broken as to almost discourage any one from attempting to utilize it. No better place in the state of Washington can be found where the measures are so exposed as to show the peculiarities of contracted strata than in section 8, township 21, range 7 east, Green river canyon. At one point the seam is seen emerging from the river and rising into the exposed side of the river bank, then it turns over again and disappears in the river in the opposite direction, all in a distance of a little over 100 feet. At the point where it turns over, in the fissures at the top of the seam and by the squeezed and contracted condition of the bottom, can be distinctly seen the crushing it has been subjected to.

Nearly the whole of King county is covered with drift carried down by glaciers from the Cascade mountains during the glacial epoch of the Quarternary period, which has in some instances covered the ground to a depth of 300 feet. Thus, were it not for the rivers and watercourses, bed-rock would seldom be seen.

In journeying closer to the mountains the eruptive rocks become plentiful and the coal measures gradually disappear, only to be seen again in small, isolated, barren patches.

The mines at Durham and Kangley are on the eastern edge of this field.

At Issaquah (formerly Gilman) there are five seams of coal, varying in thickness from three feet to eight feet between walls, dipping at an angle of about 35°. This coal is a lignite. The mine is forty-two miles from Seattle by rail and fifteen miles in a direct line.

Newcastle is four miles west of Issaquah; is a new mine, the old one having been abandoned. There are here four lignite veins, which are being worked, averaging about five feet in thickness. Dips to the north about 40°.

Renton, about five miles southwest, is working one vein (lignite) about seven feet in thickness, dipping 12° east. This mine has just been started after a shut-down of some years. There is also another mine just being started at this place, but as yet coal has not been reached.

Cedar mountain, which is some six miles east of Renton, has just been reopened, after lying idle for three years. There is here a twelve-foot vein of lignite coal.

At the next town east of this, which is Maple Valley, the Danville Coal Company has begun development work on a six-foot vein, which bids fair to become a good mine.

At Black Diamond, still further south and east, there are three workable bituminous veins, respectively five, six and seven feet in thickness.

There is also a new slope being sunk to a first-class vein of coal.

Three miles south of this on Green river is located the Denny mine. It is a six-foot vein, and is used exclusively by the Denny Clay Company at Seattle.

Next we come to Franklin, also located on Green river, where there are three mines, one having just been opened. They have a three and a six-foot vein of bituminous coal, which are being worked. There is also here a forty-foot vein, which is worked to a small extent.

The Black Diamond and Franklin coal is an excellent steam coal, most of it finding a market in San Francisco.

Beyond this are Kangley, Cokedale, Alta and Durham, at which places there are six or seven veins of coal ranging in thickness from three to ten feet; the last three places named are not working at present. There has been more development work done at Kangley than at any of these places. It has the longest slope in Western Washington, and is about 1,500 feet in length.

Scattered all along from one mile south of Palmer to as far north as Grand Ridge are dozens of holes and tunnels, on some of which considerable work has been done, especially so on those at Sherwoods, Raging Creek and Niblock.

East of Franklin about three miles, on the Northern Pacific railroad, are the American, Eureka and Navy mines. The American has from four to five feet of bituminous coal, which they are working, and also two or three veins on which some prospecting has been done. The Eureka has about the same number of veins. The Navy mine has four or five workable veins, which will average about four feet in thickness. These mines have made considerable improvement during the last three or four years.

In Pierce county we find a field small in area, not over 100 square miles, but rich in the number and thickness of its seams. The coal is of an excellent quality, of which the numerous mines situated in the belt ship large quantities to San Francisco and the cities of Puget Sound, besides the great amount made into coke at Wilkeson, which is shipped as far east as Helena, Mont. This field commences at Burnett and extends in a due south line to the Nisqually river, a distance of about twenty-six miles. It is known as the Wilkeson coal field. A portion of this district is broken up by dykes. There are nine or ten workable seams, dipping from 35° to perpendicular.

Commencing at the southern end of the county, the coal is exposed, overlooking the valley of the Nisqually river. From this point north to Wilkeson it is an unbroken wilderness. The coal crops out from the flanks of the steep mountain side, dipping usually to the east at heavy angles. The ground is covered with a magnificent growth of pine, fir and cedar trees. Over all stands Mount Rainier, 14,444 feet high, and about twelve miles distant.

At the northern end of this field several of the branches of the Northern Pacific railroad have been built up to the mines at Carbonado, Wilkeson, Burnett, Pittsburg and Acme. Carbonado shows great signs of disturbance, but the seams are so numerous and aggregate so great a thickness of coal that large outputs can easily be kept up. This is the largest producing mine in the county, if not in the state.

At Wilkeson there are two mines opened on the opposite sides of the anticlinal fold. The Wilkeson coal is used as a standard by the United States government in making comparisons of coal in this western country.

At Burnett, which is four miles farther north, at which place the South Prairie Coal Company is operating, there are two or more workable seams, dipping to the west. This coal is of great value, producing about 10,000 cubic feet of gas per ton, and is used extensively at all the Pacific coast cities for making gas.

At Pittsburg and Acme, which are farther east from Burnett and situated on the same creek, considerable work has been done. I think it can be said beyond a doubt that the Burnett seams are the same as those at Wilkeson and Carbonado. The veins vary in thickness from three to nine feet.

We now come to Lewis county. Its coal fields are divided about as follows: Anthracite, 72 square miles; bituminous, 216 square miles; and lignite, 180 square miles. In the western portion of this county the lignite veins appear dipping at an angle of about 10°. Very little as yet is known about the lignite seams. One opening has been made at Bucoda, three at Centralia and one at Chehalis. Nothing south of this has been discovered worth mentioning. As we go east we find a rich bituminous field of coal, as yet undeveloped, owing to lack of transportation. This is no doubt a continuation of the Wilkeson coal field, and the coal is considered equally as good. There are quite a number of veins exposed, varying from two to fifteen feet between walls. This coal makes excellent coke.

Still farther east is the anthracite field, but not developed for previously mentioned reason, lack of transportation. These deposits are very much mixed, and it is at this time a difficult matter to place any estimate as to their utility; but there will, no doubt, at some future time be considerable coal produced in this section of Lewis county.

In Cowlitz county, which is south of Lewis county, there are two small mines in operation, one at Castle Rock and the other at Kelso, both mining lignite coal.

Crossing the Cascades into Kittitas county, we come to Roslyn, where the Northern Pacific Company's mines are located. Here over a quarter of a million tons are mined annually, and they could produce half a million if demanded. This vein is about five feet in thickness and dips from 8 to 17 degrees south; it is a splendid steam coal and used mostly by the railroads. There are three mines at this place, and there is also one, perhaps two, small mines adjoining this field. At Cle-Elum there is a mine which is working a seam overlaying the Roslyn, and is about four and a half feet in thickness. To my knowledge all the coal discovered east of the Cascade mountains is in this county, and comprises an area of about 300 square miles.

So it is seen that the combined coal fields of the State of Washington cover an area of 1,650 square miles as far as is at present known. At the rate of the present consumption this will not be consumed for several hundred years.

There are at present only thirty-two mines in operation, giving employment to about 5,000 men, and they could give employment to more, as there is a scarcity of miners at the present time.

The Blue Canyon, Fairhaven, Black Diamond, Franklin, Kangley, Navy, South Prairie and Roslyn coal has all been tested by the United States navy, and on the whole has proved to be satisfactory.

All Washington coal is brought into competition with that of England, Australia and Vancouver Island, and compares very favorably, and were it not from the fact that this foreign coal is to a great extent brought over as ballast (consequently landed on our shores very cheap) and the low tariff, it would not be long before Washington would supply the whole Western country.

There never has been a geological survey made of this state, consequently, many errors may have slipped into this article, but on the whole I think it to be correct. It would be a life's task to arrive at the true geological formations of the state. The mountainous country, the heavy timber and undergrowth, the wash of superficial deposits, completely cover up the strata, making it a herculean undertaking. This being the condition, the mineral wealth of Washington has only begun to be discovered.

There can be no doubt that the time is fast approaching when Washington will be the greatest state in the Union for its various and vast mineral resources.

WIRE ROPE HAULAGE.

Necessity of Proper Study of Conditions in Deciding on Type.

Avoidance of Friction Necessary to Secure Most Satisfactory and Economical Results.

(By T. E. Hughes, M. E.)

(Read Before Ohio Institute of Mining Engineers.)

An interchange of ideas on a practical subject of this kind is bound to result in the common good, and if this paper does not prove an exception to the rule, it will have accomplished the purpose for which it was written.

For underground haulage there are to-day (generally speaking) three systems in operation in the bituminous coal regions of this country. 1st. The tail rope system; 2nd. The endless rope, and 3rd. The electric system. Each system has its good points as well as its weak ones, and no engineer or coal operator should let any influences have a bearing upon which method he will adopt other than those produced by the conditions as he finds them at his particular plant.

A general rule to be observed by all as to the manner of operation, would be one of the worst things to meet with in coal mining. Let me right here quote literally from an article read before the mining engineers of Western Pennsylvania, as follows: "It is very essential in deciding which system of mechanical haulage is best adapted to any particular mine, to carefully consider all the conditions to be contended with."

This vital point, which confirms my remark at the out-start, covers the true secret of a successful haulage system, be its manner of operation what it may. Hence, you will see that any remarks of the author of this paper will have to be considered in a general way, produced by observation of various plants working under very dissimilar conditions, and the suggestions being of a general nature and not applicable to any particular plant until first the conditions of said plant have been carefully studied out.

Generally speaking, a tail rope system produces more satisfactory results than an endless rope system. First, we can use a tail rope system in single gangways by carrying the tail rope between the tracks, alongside the track, or overhead. An endless system (generally speaking) calls for a double gangway, to produce economic results; *i. e.*, the carrying in of empty cars at the same time the loaded ones are being taken out. This is the first reason why the writer would advocate (where the plant admits of so doing) the use of a tail rope system.

The next reason (and it cannot be considered too carefully) is the main objectionable feature of the endless system, *i. e.*, friction. Friction, reduced down to mechanical results, means nothing more or less than wear and tear at points of contact; and if said friction or wear and tear must produce the moving or grasping the load we propose carrying, it certainly means wear and tear of something, or at some point.

There are several methods of fastening to or attaching the loaded train of cars to the endless rope, one being two pulleys mounted on a small truck, each nearly touching each other at the face when out of service, the shafts carrying these two pulleys being connected together by a right and left hand screw. When said screw is revolved it widens the distance between the pulleys, and the endless rope being passed around said pulleys, becomes taut, friction accrues, and eventually *by friction* the rope takes a permanent grip on the pulleys, and the train is moved.

Another system, and one more commonly used, is to mount on a small truck a device working on the principle of a vise operated by a screw. Thus, by the closing of the jaws, makes contact with the rope, which, when the friction has been overcome, makes the attachment a permanent one, and the load moves.

In operating a wire rope, be it for haulage or other purposes, avoid friction as you would poison. I would, at all times, advocate putting in a tail rope system for the foregoing reason, even if no other reasons or conditions warrant so doing. A tail rope system, properly put in, with boiler capacity and power of engines 25% in excess of any possible requirements, will, in nine cases out of ten, produce the best result for the capital invested.

It may have occured to some of you by this time that I have not referred to the fact that a tail rope system calls for about 50% more rope than an endless system. True. But actual experience by the rope makers, I think, will demonstrate the following to be a fact: Conditions being equal, two plants side by side, one going into a heading 10,000 feet from the power house with a tail rope system calling for 30,000 feet of rope, and another, an endless rope system, like distance and under like conditions, (if such a plant ever existed) would result in the ropes of the tail rope system lasting twice as long as the ropes of the endless rope system, thus producing a saving of 33⅓% on rope bills, where 50% more rope is in operation, this saving being produced by the necessity of replacing the endless rope twice as often as the other ropes.

Let me now refer to one or two tail rope systems working under favorable conditions that have produced very satisfactory results, and which, in a general way, could and should be duplicated anywhere else in the United States, where the coal to be handled would warrant the investment.

First, there is a plant within twenty-five miles of Pittsburgh, operating the tail rope system, the length of haul being 10,500 feet. This, as you see, calls for 10,500 feet of main rope and 21,000 feet of tail rope. Their engines are 14″x24″; drums 6 feet in diameter; they work under 80 pounds steam pressure; they haul a maximum of 90 cars per trip, loaded as follows: Coal 4,000 pounds, tare 1,300 pounds, gross 5,300 pounds. There is but little gradient, and that is a maximum of 1½% against the empty cars, *i. e.* in favor of the loaded cars. They make sixteen trips, and it takes 40 minutes to make a trip. The engines are geared 4 to 1. They use for the track a 30 pound steel rail well ballasted. Rollers 20 feet apart. The road bed is on a coal bottom, under which is a hard fire-clay, and under this fire-clay, a limestone. This, as you will see, gives what might be termed an almost ideal condition for a road bed in a coal mine. The mine is well drained to the opening or openings.

Again, I have in my mind's eye, a plant within 200 miles of Pittsburgh. The engines are 20″x30″; they are geared 3 to 1; they develop 450 H. P. while hauling the trip of 40 cars up a grade of 1 in 20; the gross tonage of load being 234 tons 880 pounds, divided as follows: coal 160 tons, cars 60 tons, weight of rope 14 tons 880 pounds. The haulage is 9,000 feet from the heading to power house. They use a 1½″ hauling rope, and a ⅞″ tail rope. One of the main ropes of this latter plant is still in service, and its mate was taken off this last summer. I forgot to state that this is a double tail rope system. The main rope and tail rope taken off last summer, hauled 1,200,000 tons of coal; consequently, you will see, by a short process of figuring, the cost of the rope per ton hauled was remarkably low.

The plant first referred to does not have any hard conditions of grade; in other words, the maximum grade is 1½% in favor of the load. They have hauled out over 1½ million tons of coal with 30,000 feet of ⅞″ crucible steel haulage rope, costing as you will see, 2⅕ cents per 1,000 tons for haulage.

Having now referred to a couple of plants hauling coal under favorable commercial results, I now want to switch back again to general conditions to be observed for operating rope haulages, be they endless, or tail rope. Perhaps one of the most vital and beneficial changes that our engineers have made, is that, where we have to make a turn in our gangway at a right angle (or nearly so), they, wherever it is possible, now introduce the reverse curve to overcome the strain resultant from using a guide wheel or carrier. By using the reverse curve, you can see at a glance we get a much greater radius, and naturally much less bind or set in the rope than under the old conditions. Again, the mining engineer reverses the conditions of the steam railway engineer in the following way: He elevates the inside rail above the level of the outside rail, owing to the fact that the pull of the rope will have a tendency to increase friction if the rails are on a level, while on the contrary *it is a question of momentum* to be overcome when the engineer of a steam road elevates the outside rail of a curve instead of the inside, as the mining engineer does.

It will not do to leave this discussion without noticing another important factor in a well equipped plant—that is, the kind and construction of the rope that you use. The kind most commonly used for haulages is composed of six strands of seven wires each laid around a hemp centre. The wires (generally speaking) being made of steel.

A rope that has received more attention than its merit warrants is what is known as the "Lang lay" rope. This rope is composed of the same number of wires and strands as the commonly used haulage rope, but differs in this respect: The strands when being twisted together are twisted in the same direction as the wires have been in each particular strand.

This produces a much more *flexible* rope than the rope made in the way known as *standard* lay, the strands in the standard laid rope being laid up in the opposite direction to the lay of the wires in the strand.

A flexible rope is a desirable one, if we do not sacrifice some element of vital force equal to or greater than what we gain in flexibility.

There are exceptional cases (which the discussion of this paper may bring out) wherein the Lang lay rope is the most advisable, but, generally speaking, the Lang lay rope does not give as good service as the standard lay.

By examining a section of a Lang lay rope, you will see that the wires run over the pulleys at an angle of about 45 degrees, if each and every pulley is in an ideal condition, *i. e.*, running true, well lubricated, and in first-class condition. This will not make a material difference in the life of the rope; but, are these conditions ever lived up to? We would say "No;" consequently, at just exactly the ratio of the condition of the passing from the ideal to the actual, just at the same ratio does friction come in in the wear of the wires on the Lang lay rope over and above what would be the case with the standard lay.

To further illustrate this, you will notice that when a mechanic is using a file in filing a piece of metal, he takes the position of the file at exactly the same angle at which these wires are laid, to produce the best results, *i. e.*, cut away the metal to the greatest amount with each stroke of the file. If the mechanic will do it with that object in view, does not the same result follow with the Lang lay rope, when passing over the pulleys full of grit and dirt? Such being the case, rope manufacturers (generally speaking) recognizing that fact, have insisted on the use of the standard lay rope to produce the best results for the operator.

You will notice in the standard lay rope that the wires lay parallel with the motion of the rope, and for this reason, when passing over pulleys, expose the smallest amount of surface of each wire for friction that is possible, and by so doing the rope has a tendency to *slide* over the pulleys rather than scrape them.

Again using the file for an illustration, if you put the file in the mechanic's hand and tell him to push it over the metal he is filing, with the teeth of his file parallel with the motion of the stroke, he will at once tell you that his file will slide over the material instead of cutting it. This illustration will best serve my purpose in my effort to indicate why the Lang lay rope will not give as good service (generally speaking) as the standard lay.

There are (as I have intimated) exceptional cases where the Lang lay rope will work, but only exceptional, they being perhaps controlled by the following conditions: "A high speed motion, very small drums, and numerous angles in the operation of the plant."

Under these conditions, perhaps it might be advisable to use the Lang lay, on account of its extra flexibility over and above the ordinary haulage rope made of seven wires to the strand; and even in this condition, it is a question which only a rope manufacturer should decide, as to whether a rope made of nineteen wires to the strand (standard lay) would not give better service than a rope made Lang lay, seven wires to the strand.

This illustration once more forces upon us—and, like Banquo's ghost, "will not down"—the fact that friction is an expensive luxury, and only those who need not care what the expense of the luxury is so they have it, should ignore its cost.

Before leaving the subject of haulage, we might be considered behind the time if we made no reference to the latest development, *i. e.*, "electric haulage."

Electric haulage (as being introduced to-day) means haulage by traction, and (getting back to our old hobby again) traction means friction.

The problem—a simple one—is, we must move a given load (the power needed it is presumed we have at our command) by a sufficiently heavy motor to give us the required traction, or, in other words, sufficient to reduce the friction between the motor wheels and the rail to *nil*. This (after careful investigation) I am firmly convinced has, as yet, not been successfully accomplished (looking at the question of commercial economy and success).

Of course, I realize this remark will bring down on my unprotected head, an avalanche of criticism from our electrical engineers, yet I will frankly say right here, that if I am mistaken, I am as anxious as they are to see the error of my ways, and only too gladly will make due apologies and concessions for such discrepancies as they may point out to me, but, as I now see it, there is not in operation, to my knowledge to-day, an electric haulage system giving the desired mechanical results, and I would be willing to guarantee to exceed said mechanical results on less than 75% of the capital invested in the electric installation, by substituting wire rope; hence, if this is so, electricity, is as yet, economically speaking, a failure. In fact, let me close these remarks by suggesting that some of the rules that are given us for success when seeking happiness will apply fully as forcibly when applied to seeking coal—"avoid friction."

Take the best of care of the health of your plant. See that all things work in harmony. See that "the joints" are well lubricated. See that each part of "the plant" performs its particular duty. See that it gets the daily care that it should have to enable it to do to-morrow's work as ably as it did to-day's, and rest assured it will live to a ripe old age, and make all happy who come in contact with it.

ANTHRACITE TONNAGE ALLOTMENT.

A Satisfactory Schedule Adopted by the Presidents of the Anthracite Coal Roads.

The result of the meeting of the presidents of the anthracite coal roads held in New York City on the 30th ult., is a most satisfactory settlement of a dispute that for many months has had a disastrous effect on the anthracite coal trade.

Inability to arrive at a satisfactory allotment for each road was due to the receivers of the Philadelphia and Reading Company, insisting on 21 per cent. of the total tonnage for their road. As a result no attention was paid to proportionate tonnages, and each company rushed as much coal to market as possible. This naturally glutted the market and ruinously low prices prevailed. The claim of the Reading Company to 21 per cent. of the tonnage was one that the receivers of the company, and many others conversant with the Reading's coal property, considered a fair one, but the management of the other roads claimed that the advent of new roads, in the transportation business, together with certain other features, had changed old conditions so much that the Reading as well as some of the other older roads would have to submit to a smaller percentage of allotment.

A meeting of the presidents of the coal roads was called for January 23rd, but failed to come to an agreement, and a committee was appointed to make up a report relative to the division of the tonnage for the year 1896.

This committee made its report on the 30th ult., to a meeting which was attended by the following gentlemen:—Samuel Sloan, Delaware, Lackawanna and Western Company; E. P. Wilbur, Lehigh Valley Railroad Company; J. S. Harris, Philadelphia and Reading Railroad Company; J. Rogers Maxwell, Central Railroad of New Jersey; Eben B. Thomas, Erie Company; Alfred Walter, Delaware, Susquehanna and Schuylkill Company; Thomas P. Fowler, New York, Ontario and Western Company; Simon Borg, New York, Susquehanna and Western; R. M. Olyphant, Delaware and Hudson Canal Company; Geo. B. Roberts, Pennsylvania Railroad Company.

The report, which was adopted, makes the following allotments:—

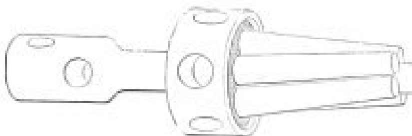
Delaware, Lackawanna and Western R. R.	13.35	per cent.
Delaware and Hudson Canal Co	9.60	"
Pennsylvania R. R	11.40	"
Philadelphia and Reading R. R	20.50	"
Lehigh Valley R. R	15.65	"
Central R. R. of N. J	11.70	"
N. Y., L. E. & W. R. R	4.00	"
Pennsylvania Coal Co	4.00	"
N. Y., Ontario and Western R. R	3.30	"
Delaware, Susquehanna and Schuylkill R. R	3.30	"
New York, Susquehanna and Western R. R	3.20	"
	100.00	

These percentages became operative on the 31st ult., and they will continue in force until January, 1, 1897. They shall be subject to revision after thirty days from that date. The satisfactory solution of this troublesome question makes easy and practicable, a rational policy of restriction of production, which is an absolute necessity. Metropolitan newspapers, and some poorly informed journals in the anthracite regions oppose this policy of restriction, but every man conversant with the anthracite coal business, and who has the interest of all classes in the region at heart, favors it. It is simply good business policy, which if properly carried out means a fair profit to the operator and fair wages to the miner. It may mean, and probably will mean, periodical suspensions at the mines, but such suspensions voluntarily made to maintain fair prices for coal are infinitely better than forced suspensions due to an over-crowded market and the consequent break in prices.

The Johnson Self-Feeding and Self-Releasing Tube Expander.

Mine managers and all who have the care of tubular boilers will be interested in the Johnson improved tube expander, which we herewith illustrate.

It is the only radical improvement in flue expanding devices since Richard Dudgeon's expander was invented many years ago. The new expander requires neither to be driven in nor out. It is self-feeding and self-releasing. It is very simple in construction, and the wear is so evenly distributed that the manufacturers claim that "while it may wear smaller, it will not wear out."



JOHNSON TUBE EXPANDER.

This is a feature that will be appreciated by all who have been worried by the necessity for continually repairing and replacing the old style expanders.

The Johnson expander has been sold extensively to the railroads and ship building trade during the past two years by a Philadelphia firm, but the Johnson Tool Co., of Wilkes-Barre, which has just been organized, will hereafter manufacture the expander, and will pay special attention to the mining trade. The expanders are made in all sizes from $1\frac{1}{2}$ inch, up, and a small publication entitled "Some Facts" issued by the manufacturers, which is sent free on application, gives important information concerning the tool.

"Watt" Mining Car Wheels.

With this issue of The Colliery Engineer and Metal Miner, the Watt Mining Car Wheel Co., of Barnesville, Ohio, begin a series of advertisements of the cars and car wheels made by them. This concern in their advertisement in this number (page xiv) show a truthful illustration of their works, which, without doubt, is the largest manufacturing plant in America devoted wholly to the making of mine cars and mine car wheels.

The business which has required the establishment of such a plant has been built up mainly on the Watt Self-Oiling Wheel, which has met a very favorable reception from mine operators and superintendents throughout all American mining regions where it has been introduced. The shops shown can, without crowding, turn out 160 car wheels and 20 to 30 finished cars per day. The Watt Co. is also prepared to furnish axles and car irons to any specification.

It will be worth while for mine superintendents and buyers to follow closely the advertisements which we shall publish for this concern, for in each one hereafter, some special style of car (with notes as to where used) or some component part of special design, will be illustrated. Some new things the Watt Co. will soon put on the market will be illustrated there at an early date.

Catalogues, Etc.

The Link Belt Engineering Co., of Philadelphia, has issued an artistic edition of advance sheets from their 1896 catalogue, which illustrate and describe the well-known and highly efficient Monobar conveyor.

Mr. Robert Allison, of the Franklin Iron Works, Port Carbon, Pa., has issued a neat catalogue of air compressors, pumps, high speed engines and general mining machinery made on the lines of his well known original designs.

Bulletin of Catalogue No. 30, Vol. I, Part 3, is the title of a folder issued by The Ingersoll-Sergeant Drill Co. It illustrates and describes air compressors and contains valuable matter pertaining to the use of such machinery.

A handsome souvenir catalogue with illuminated cover illustrates and describes the Thomson recording wattmeters. The third publication is an artistically bound set of 31 plates, illustrating by fine engravings various electrical machines and plants erected by the General Electric Co.

The Hine & Robertson Co., who make a specialty of steam plant appliances, issue a neat little pamphlet, entitled, on an artistic cover, "Waste Not, Want Not." The old adage is very applicable to the Hine & Robertson Co.'s specialties, as their goods are designed to produce the most economy possible in power plants.

We have received from The General Electric Co., No. 44 Broad street, New York, copies of three handsome publications issued in connection with their exhibit at the Atlanta Exposition. One is a twelve page folder, containing, besides other illustrated matter, three full page views of their works at Schenectady, N. Y.; Lynn, Mass.; and Harrison, N. J.

RIEDLER PUMPS.

Their Efficiency and Economy Attested by First Class Mining Authorities.

We recently published a description and cut of the Riedler Pump, manufactured by Messrs. Fraser & Chalmers of Chicago, and in a general way gave the opinions of purchasers as to its merits. We are now able to supplement the description, etc., by the following extracts from the official reports of the Montana Mining Co., Ltd.,

From report of Mr. R. T. Bayliss, general manager, to the chairman and directors, Oct. 23rd, 1895:

"*Riedler Pumping Engine.*—This plant, which has recently been erected in the 1,600 ft. level, was rendered necessary owing to the greater quantity of water met with in the developments at the bottom of the mine, and consists of a duplex differential Riedler pump, with plungers $3\frac{1}{4}$ in. and $5\frac{1}{2}$ in. in diameter, and 24 in. stroke, actuated by a horizontal compound condensing Corliss engine, with cylinders 16 in. and 25 in. in diameter, and 24 in. stroke, and has a capacity of 400 gallons per minute against a head of 1,230 feet, when running at 90 revolutions. At the present time it is working to about one-third of its capacity, therefore it will be able to handle without difficulty any quantity of water which we may reasonably expect to encounter in these workings. The erection of this pump has resulted in a saving of not less than 60 per cent. in the consumption of fuel hitherto necessary for operating the ordinary steam pumps which were previously situated in the 700, 1,000 and 1,200 ft. levels, and it is evident that by this economy of fuel alone, the Riedler pump will repay the cost or its erection in eighteen months. In addition to the saving in the consumption of fuel, a considerable economy is effected in the labor and repairs necessitated by the operation of the pumps formerly in use; and it may be safely assumed that the introduction of the Riedler pump will enable us to unwater the mine at an expenditure not in excess of 25 per cent. of that incurred under the old system. I may mention it is only within the past two years that the Riedler pump has been introduced into the United States, although it has been for some time extensively used in Germany, Austria, and other European countries.

In conclusion, I desire to assure you that the operation of your mine and works is being conducted in an admirable and economical manner by the various members of your staff, who, by their long service, are eminently fitted to occupy the positions they hold; and I further desire to express my personal indebtedness to them one and all for the assistance rendered me in the administration of the company's affairs.

Believe me, Gentlemen,

Yours faithfully,

(Signed), R. T. Bayliss."

From report of the mining engineers, Messrs. R. W. Raymond and T. A. Rickard, to R. T. Bayliss, Esq., general manager:

"The admirable Riedler pumping plant recently placed on the 1,600 level will permit operations to be prosecuted to any extent, on or above that level, without fear of any disturbance of the regular work of the mine by a sudden influx of water. This pump is undoubtedly adequate to handle all the water that can be encountered above the 1,600. It is now taxed to only one-third of its capacity; and most of the water comes from above the 1,600 level. Yours truly,

(Signed), R. W. Raymond, T. A. Rickard."

Immunity of Colliers from Cancer.

Mr. T. Law Webb, of Ironbridge, whose labors to elucidate the cause of cancer are well known, in an interesting paper on the subject, states that he has practiced for twenty-five years in a district overlying the Shropshire coal-field, and during that time he has been surgeon to two collieries, yet he has never seen a single case of cancerous disease in a collier who was working in the pits. "Moreover," he says, "an examination of the books of the district registrar shows that of all persons whose deaths are registered as due to malignant disease during the past thirty years, only two are described as 'coal miners.' Of these, one I know positively had long retired from the arduous occupation of coal-getting, and had for many years followed the more gentlemanly occupation of rat-catching. The other died in the workhouse, and had not worked in the pit for some time. It should be borne in mind that in this same locality cancer is very common, and is often seen among the furnacemen, moulders, iron-workers, and general laborers." Another practitioner living in the same district is also unable to recall the case of any collier suffering from cancer. The explanation lies partly, Mr. Webb thinks, in the habitual cleanliness of the collier, who "tubs" daily as soon as he comes home from the pits; partly in the fact that his habits rarely lead him to drink water from casual sources. He goes to work early, and habitually in his working hours carries with him a quart can containing cold tea or coffee, without milk. He always returns home to dinner, at which he usually drinks tea, or, if he can get it, small beer, while his supper consists of bread and cheese, with sometimes an onion and a pint of beer. The colliers in Shropshire are a temperate, peaceable, law-abiding class, not given to excesses of any kind. Though they are often seriously injured in their dangerous occupation, they survive the most dangerous wounds and fractures, and although they look pale and anaemic, they are in reality a healthy set of men.—*Science and Art Mining.*

EXPLOSIVES FOR COAL MINES.

Their Classification, Composition and Gaseous Products of Combustion.

A Comprehensive Study of the Safest Explosives for Use in Gaseous and Dusty Mines.

By Prof. Vivian B. Lewes, Royal Naval College, Greenwich, Eng. (From Transactions of the Federated Institution of Mining Engineers.)

Last winter the writer had the honor of delivering a course of Cantor lectures before the Society of Arts, on the subject of "Explosives and Their Modern Development," and in the last lecture of that course dealt with mining explosives, and showed, to his own satisfaction at any rate, that all explosives which give rise to carbon monoxide as a product of their combustion ought to be strictly tabooed for use in coal mines, not only because of the risk of injury to health and life from the poisonous nature of the gas, but also because even small traces of carbon monoxide render mixtures of coal dust and air highly explosive, a point which has, he thinks, been entirely overlooked in all experiments upon this most important subject.

Up to thirty years ago, gunpowder and a modified form known as blasting-powder were practically the only explosives used in mines, and the discovery of the detonation of nitro-glycerine by Mr. Alfred Nobel in 1864, and its introduction under the name of "Nobel's blasting oil," marks perhaps the most important epoch in the history of blasting explosives. After that date many and varied attempts were made to introduce new explosives which should combine the important properties of safety and efficiency. Blasting oil soon showing its dangerous character, restrictions were placed upon its use and transport, and very shortly after its introduction attempts were made to tame its explosive properties without reducing the strength of the explosive itself, efforts in this direction giving rise to dynamite and other mixtures of this class, in which nitro-glycerine was taken up by some absorbent material, and by practically converting it into a solid form did away with many of the dangers inseparable from the liquid state, and also enabled it to be more effectively detonated.

As time passed on it became manifest that there was still room for improvements in explosives for mining work, and Dr. Sprengel suggested in 1873 the possibility of mixing together hydrocarbons, built up from the elements carbon and hydrogen and containing them in a condition easily available for combustion, with highly oxidizing bodies—in such proportions that complete combustion would be ensured. Many attempts were made to utilize this suggestion, and thirteen years after he had read his paper before the Chemical Society, several so-called safety Sprengel explosives were introduced into this country, and have proved themselves to be a considerable advance in safety and reliability over their predecessors.

In reviewing the properties of the various mining explosives now in use in coal mines, it will be convenient to classify them according to the way in which they produce the gas which gives the explosive effect.

Class I.—Explosion due to simple combustion, as in the case of blasting gunpowder.

Class II.—Explosion due to detonation of the whole of the explosive, as in nitro-glycerine, nitro-cotton, and some Sprengel explosives.

Class III.—Explosion due to detonation of part of the explosive and combustion of the remainder, as in carbonite, westfalit, etc.

This may at first sight seem to be an awkward and unreasonable method of classification, but inasmuch as the claims of any explosive for mining purposes must in the first place be based on its safety as regards the non-ignition of explosive mixtures in the workings of a coal mine, and as this in turn largely depends upon the way in which the explosive generates its force, the writer prefers to adopt it in view of the considerations which he wishes to bring before the members.

COMPOSITION OF POWDERS.

	Gunpowder.	Blasting Powder.		
		England.	France.	Italy.
Potassic nitrate	75	65	62	70
Sulphur	10	20	20	18
Charcoal	15	15	18	12
Totals	100	100	100	100

GASEOUS PRODUCTS OF COMBUSTION.

	Gunpowder Fine Grain.	Mining Powder.
Carbon dioxide	50.62	32.15
Carbon monoxide	10.17	33.75
Nitrogen	33.20	19.03
Sulphuretted hydrogen	2.18	7.10
Marsh gas	0.19	2.73
Hydrogen	2.96	5.22
Oxygen	0.08	0.00
Totals	100.00	100.00

The most characteristic types of the first-class are ordinary black gunpowder and blasting powder, both mixtures of the combustibles carbon and sulphur with potassic nitrate as the oxidizing material, the great difference between the two being that whilst in ordinary gunpowder the proportions are so arranged as to give great heat-energy to the explosion, in blasting powder a slight lowering of temperature is obtained by increasing the proportion of sulphur present, and reducing the oxidizing material, the result being that during explosion, the products of combustion although increased in volume, consist largely of imperfectly oxidized bodies which are themselves inflammable.

Gunpowder itself is practically never used, and the only word that can be said in favor of the blasting powder is that it is cheap. It is absolutely unfitted for use in coal mines, and its abolition would do away with more than three-quarters the number of deaths annually returned as being caused by mining explosives. The great danger attending its use, however, consists in the combustible nature of the products evolved during decomposition, a factor in coal mine explosions which the writer ventures to think cannot be overrated.

On firing a charge of 1½ lbs. of blasting powder, over 3 cubic feet of combustible gas, consisting chiefly of carbon monoxide, would be produced, and this when mixed with pure air, would give over 10 feet of an explosive, or at any rate rapidly burning mixture, and experiments which have been made upon the effects of fire-damp and dust combined in causing colliery explosions, show conclusively that even when fire-damp is present in such minute quantities as to form a mixture very far removed from the point of explosion, it makes the mixture of coal dust and air highly explosive. Traces of carbon monoxide will do exactly the same thing when the air is laden with coal dust, whilst the temperature of ignition is lower than with methane, so that when the air of the mine is charged with coal dust, the probabilities are that a very large volume of explosive mixture is formed by the rapid escape of the products of combustion into the dust laden air, and this (being ignited either by the flame or by red hot solid products driven out into it by a blown out shot) initiates a considerable area of explosion.

As the explosion takes place, and as the carbon monoxide already produced is oxidized to carbon dioxide by the action upon it of water vapor present, and also by its direct combustion with oxygen, the hydrogen of the water vapor is set free, whilst the heated coal dust also yields certain inflammable products of distillation to the air, and partial combustion of the coal dust gives a considerable proportion of carbon monoxide once more, and this, driven rapidly ahead of the explosion, forms, with more coal dust and air, a new explosive zone, and so, by waves and throbs, the explosion is carried through the dust laden galleries of the mine.

In this way any explosive which generates inflammable products of incomplete combustion is unsafe, and should never be used even in mines where fire-damp is unknown, as such explosives are quite capable of setting up an explosion with coal dust alone.

A still greater danger arises if any trace of fire-damp exists in the mine, as this, together with dust, provides an already explosive atmosphere, whilst the products evolved by blasting powder are capable of playing the same part as sulphur on a match, and causing ignition of the explosive mixture.

Fire-damp, as has been shown by the numerous experiments made since Sir Humphrey Davy's memorable researches, is not easily inflamed, and explosive mixtures containing it not only require a temperature of over 1,200° F., but require this temperature to be applied for several seconds, sometimes as many as ten, before ignition takes place.

This phenomenon is due to the absolute ignition point of methane being extremely high, far higher than the temperature at which it decomposes into hydrogen and acetylene, and the result is that at a temperature, such as 1,200° F., decomposition of the methane molecules first takes place, and the liberated hydrogen then igniting raises the mass to the true ignition point of the methane. This dual action requires an appreciable time, and it is this alone which gives the comparative safety in mines where any trace of fire-damp exists.

If we take the temperature developed by the more prominent explosives, we find them to be far above the ignition point of explosive mixtures of methane and air for a steadily applied heat.

	Degs. Cent.	Degs. Fahr.
Blasting gelatine	3,220	5,828
Nitro-glycerine	3,170	5,738
Dynamite	2,940	5,281
Gun-cotton	2,650	4,802
Tonite	2,648	4,798.4
Picric acid	2,600	4,712
Roburite	2,100	3,812

Whilst the ignition point of explosive mixtures of the various combustible gases which could be present in the working of the mine, either produced by the use of improper explosives, or liberated by the coal, are about:

	Degs. Cent.	Degs. Fahr.
Methane	660	1,220
Ordinary coal gas	648	1,198.4
Carbon monoxide	640	1,184
Hydrogen	620	1,148
Ethane	605	1,121
Ethylene	580	1,076
Butylene	540	1,004

It is manifest, therefore, that if the products of explosion escaped into the mine at this temperature, any explosive mixture in the mine must be ignited. This temperature, however, only exists while the gases are under the pressure generated by the explosion; and directly they blow out into the workings, expansion instantly cools them below the temperature necessary to bring about the changes leading to the ignition of mixtures of methane and air, or methane, air, and coal dust.

It is important that it should be fully realized that the factor of safety depends to a great extent upon the retarding influence of the chemical changes necessary before the ignition takes place, and it is the absence of this with explosive mixtures of other gases that constitutes a real source of danger.

Fortunately the inflammable constituent of pit gas is practically only methane, and with the use of proper explosives, *i. e.*, explosives which can be completely detonated, and which give neither combustible products nor burning solids on explosion, a very fair degree of safety is attained.

Directly, however, inflammable gases, other than methane, are introduced, the margin of safety disappears, and with explosive mixtures which contain carbon monoxide, hydrogen, or ordinary illuminating coal gas, the point of ignition being the true one, no time is given for the products of the explosion to cool themselves down below the ignition point, and the gaseous mixture is fired.

It will always be noticed that in making trials with various explosives where pit gas is used for the mixture in which the explosive is fired, ignition is rare, whilst with mixtures of air and coal gas, ignition is the rule rather than the exception; and surely no one can believe that this depends upon the few degrees higher point of ignition which the methane is supposed to possess, and it is this obliteration of the factor of retarded ignition which makes it imperative to discard any explosives generating combustible products of incomplete combustion for use in fiery coal mines.

It is also evident that the more rapid the explosion the safer will it be, and no explosive should be used which relies upon simple combustion either as a primary or secondary principle in its action.

A still greater source of danger found in the explosion of most blasting powders is the excess of sulphur which it contains, and which during explosion shows its presence by the evil odor of the escaping gases which contain over 7 per cent. of sulphuretted hydrogen, whilst under certain conditions traces of carbon bisulphide are also produced.

As has been already pointed out, the ignition point of carbon monoxide is about the same as ordinary coal gas, and may be taken as being 1,184° F., but the vapor of carbon bisulphide has an extremely low point of ignition, and the admixture of only 3 per cent. of its vapor with carbon monoxide lowers the igniting point to below 400° F.

Blasting powder and other explosives of the first class should unhesitatingly be discarded not only as being unsafe in use, but also as deleterious to health, the products of incomplete combustion all having a distinct toxic effect on the system.

Taking now explosives of the second class, we come to nitro-glycerine, nitro-cotton, and some of the Sprengel explosives, and the distinctive characteristic of this division is that all the members of it are capable of complete detonation, provided always that the right sort of detonator is employed.

Nitro-glycerine, which first inaugurated the modern era of high explosives and commenced its career as blasting oil, stands apart from all other nitro compounds, owing to the fact that it contains more oxygen than is necessary to complete the oxidation of the carbon and hydrogen found in its molecule.

Nitro-glycerine

$$2\,[\,C_3H_5\,(NO_3)_3\,] =$$

Carbon dioxide, Water, Nitric oxide, Nitrogen

$$6\,(CO_2) + 5\,(H_2O) + NO + N_2.$$

The result being that it evolves no combustible products, whilst its rapidity of detonation would make it the safest and best of all the blasting explosives—were it not for the danger inseparable from its physical condition and sensitiveness to shock.

When first introduced it achieved considerable success, as the fact of its being unaffected by moisture gave it a great advantage, whilst the rapidity of its explosion made it only necessary to prepare a borehole, partly fill it with nitro-glycerine, and then fill up the hole with water, the water forming just as good a tamping for the nitro-glycerine when fired by detonation as if the hole had been plugged with wood or metal. The use of nitro-glycerine for blasting purposes is however attended with several inconveniences, as being fluid it can only be used for downward boreholes, whilst its transport in the liquid form has given rise to many accidents; and, finally, the liquid state is not very suitable for detonation, as the fluid yields to the sudden blow, and is often scattered instead of being completely exploded, so reducing its power and becoming a source of danger in subsequent operations.

When cautiously heated to 100° Cent. it slowly evaporates, at 200° Cent. it burns, and detonates at 257° Cent. When a lighted match is applied to it, it burns quietly away, and when the light is removed the flame generally goes out; indeed a lighted match may be extinguished by plunging it into nitro-glycerine. It is, however, detonated by a sudden blow, or by heating it to 257° Cent. Nitro-glycerine becomes solid at 4° Cent., but so much depends upon the length of exposure to cold that this may happen at from 8° to 11° Cent., and in this condition it is comparatively inert; hence it is necessary to thaw it before use, an operation attended with considerable risk. It is stated that exposure to the direct rays of the sun will convert it into a very unstable and explosive substance, and also that the presence of ozone will sometimes cause its spontaneous decomposition.

The general instability of nitro-glycerine, the liability to freeze, and the danger in thawing extends to the mixtures in which it plays an important part, and exudation of nitro-glycerine from mixtures containing it is a danger so well realized that it is needless to dwell upon it.

Moreover, some of the best of the nitro-glycerine class of explosives, such as blasting-gelatine, are among the worst offenders as regards the evolution of combustible products of combustion, as the deficiency in oxygen of the nitro-cotton employed is not made up for by the excess present in the nitro-glycerine used.

Such smokeless powders as cordite and ballistite are of much the same character as blasting-gelatine, and in all of them we find the same evolution of combustible and poisonous products marring otherwise beautiful explosives.

PRODUCTS OF COMBUSTION OF MIXTURES OF NITRO-COTTON WITH NITRO-GLYCERINE.

	Blasting Gelatine.	Ballistite.	Cordite.
Non-combustible—			
Nitrogen	20	22.2	19.2
Carbon dioxide	34	35.9	24.9
Combustible—			
Carbon monoxide	36	32.6	40.2
Hydrogen	10	9.0	14.8
Methane	trace	0.3	0.7

It is the nitro-cotton present in these explosives which is responsible for the bulk of the carbon monoxide, whilst in cordite the vaseline present, by supplying extra carbon, gives a still larger quantity, although more highly nitrated cellulose is employed in making it than in the case of blasting-gelatine.

Nitro-cotton alone has from time to time been used for blasting work, but in this case we obtain the maximum amount of combustible products. The following analysis shows the products from a nitro-cotton containing 13.3 per cent. nitrogen on detonation :—

Non-combustible—	
Nitrogen	16.9
Carbon dioxide	22.3
	39.2
Combustible—	
Carbon monoxide	45.1
Hydrogen	14.9
Methane	0.5
	60.8

The amount of carbon monoxide produced can be reduced by admixture with various oxidizing materials, and Prof. Harold B. Dixon's observations as to the oxidizing action of water vapor upon carbon monoxide are well illustrated by the fact that if wet and dry nitro-cotton be detonated there is a notable reduction in the quantity of carbon monoxide yielded by the wet sample, and an increase in the hydrogen, showing that the water present has been acting as an oxidizing agent.

When detonated the gaseous products of the composition are :—

	Wet Gun-cotton.	Dry Gun-cotton.
Carbon dioxide	32.24	24.24
Carbon monoxide	27.12	40.50
Hydrogen	26.74	20.20
Nitrogen	14.00	14.86
Methane	0.20	none
Totals	100.30	99.80

Several explosives have been made on the principle of mixing nitro-cotton with oxidizing materials, but the only one of these still in the market is tonite, in which the generation of carbon monoxide is reduced by mixing the nitro-cotton with mineral nitrates. Such mixtures, however, give rise to a residue of fused salts, which, if blown out into an explosive atmosphere, would be extremely liable to ignite it, and although the combustible gases evolved are reduced in quantity they are not done away with.

Besides nitro-glycerine and nitro-cotton, such of the Sprengel explosives as are capable of complete detonation come under this group. The Sprengel explosives have been largely used for blasting purposes, both abroad and in this country; those used here consist of mixtures of nitrated hydrocarbons and ammonium nitrate.

Roburite, introduced by Dr. Carl Roth, is a simple mixture of nitrate of ammonium with chlorinated meta-dinitro-benzol. The ammonium nitrate is first dried and ground, then heated in a closed steam-jacketed vessel to a temperature of 80° Cent., and the melted organic compound is added, and the whole stirred until an intimate mixture is obtained. On cooling, the yellow powder is ready for use, and is stored in air-tight canisters, or is made up into cartridges. Owing to the deliquescent nature of the ammonium nitrate, the finished explosive must be kept out of contact with the atmosphere, and for this reason the cartridges are waterproofed by dipping them in melted wax.

This mixture is not exploded by ordinary percussion, firing, or electric sparks. If a layer of the explosive is struck a heavy blow with a hammer, the portion directly receiving the blow is decomposed, owing to the heat developed, but no detonation whatever takes place, nor are those portions of the substance around the spot in any way affected, whilst if roburite be mixed with gunpowder, and the gunpowder be then ignited, the latter explodes and scatters the roburite without firing it.

Roburite can only be exploded by a specially powerful detonator, and on decomposition the gases evolved contain no combustible constituents, but consist only of carbon dioxide, water, and nitrogen, with a small trace of hydrochloric acid gas, which is at once condensed by the large volume of water vapor evolved, and gives rise to no inconvenience.

Ammonite is another explosive of this class, which is manufactured from ammonium nitrate and dinitro-naphthalene, these substances being blended in the proportions necessary to give as the products of combustion carbon dioxide, water vapor, and nitrogen, but during the decomposition taking place, probably some more complex action occurs, as small traces of ammonia can generally be detected.

Bellite consists of a mixture of dinitro-benzene with ammonium nitrate, the latter being kept rather in excess.

Securite consists of ammonium nitrate and dinitro-benzene, but from the proportion of nitrate used it is probable that carbon monoxide is produced. The cartridges are coated with nitrated resin, in order to protect them from the action of the atmosphere.

There is no doubt but that this group of explosives approaches more nearly to real safety-explosives than any which have yet been introduced.

The low temperature of explosion secured by the use of ammonium nitrate, the absence of any combustible products of decomposition—except perhaps with securite—and the fact that both the oxidizing material and the combustible are capable of complete detonation with a sufficiently powerful fuse, gives these explosives enormous advantages over any others to be obtained, whilst they are absolutely safe in handling.

The safety of the Sprengel explosives in handling and use is to a large extent dependent upon the fact that when the mixture of ammonium nitrate and the nitrated organic body is ignited by ordinary flame, the ammonium nitrate requires a large amount of heat for its decomposition, in order to render the oxygen which it contains available for the combustion of the carbon and hydrogen in the organic body, and the temperature of the burning substance is not sufficiently high to propagate this action throughout the mass, the result being that to cause continued combustion you must have a continuous supply of heat, or the flame first started simply dies out.

The effect of this is that in handling, such bodies are practically non-inflammable, and when they are made to explode by detonation, a more than usually powerful detonator has to be employed, so that although with nitro-glycerine mixtures a charge of 7 grains of mercuric fulminate is amply sufficient to produce detonation, such a body as roburite needs at least 15 grains. Moreover, when detonation has been produced, the amount of heat absorbed by the decomposition of the ammonium nitrate causes a very considerable lowering of the temperature of explosion.

To the writer's mind, it is an absolute *sine qua non* that in an explosive mixture for mining work, all the constituents should be capable of detonation, and the reason for this is that under these conditions the shock of the detonator resolves both the oxidizing and combustible bodies into their respective molecules, and that these then recombine into the gaseous forms which give the explosive force, the whole action being practically instantaneous, and causing the projection of the hot products with such velocity as to give no time for the decomposition of the methane in the pit-gas, and the ignition of its constituents.

In order to obtain the requisite rapidity of explosion for ensuring safety as regards the ignition of gaseous mixtures in the pit, the reacting portions of the explosive must be in the condition of molecular division, and for blasting purposes this can only be obtained by complete detonation. It is impossible to obtain safety by any attempt at mechanical division. An excellent example of this is to be seen in westfalit, which is said to be made by mixing 95 per cent. of ammonium nitrate with 5 per cent. of shellac or resin dissolved in alcohol, the alcohol is driven off by heat, and the mixture is ground and made up into cartridges. In this mixture the resin or shellac cannot be detonated, and the presence of the inert material necessitates the use of a No. 9 detonator, containing 2.5 to 3 grammes of fulminate, to explode the mixture, and when detonated the ammonium nitrate only is decomposed, and the simple combustion of the resinous matter by the products follows as a secondary reaction, with the result that the period of explosion is very sensibly increased, and the risk of ignition of the pit gases becomes much greater. The resinous material undergoing combustion is also a grave source of danger, as, instead of being in a molecular state of division, the smallness of the particles is governed by the degree of fineness to which it is ground, and a blown-out shot would be accompanied by a shower of sparks of the burning resin. The fine condition into which it must be ground must also increase the troubles due to the hygroscopic nature of the ammonium nitrate. On these grounds one would expect westfalit to be the least efficient and least safe of the Sprengel explosives.

In deciding as to the relative claims of the other members of the Sprengel group, ammonium nitrate being common to all, the best will be the one in which the nitrated combustible is the most susceptible to detonation, as this reduces the chance of miss-fires or partial detonation as well as increases the rapidity of explosion, and the writer should expect the chloro-dinitro-benzol used in roburite to answer best to this requirement.

The third group of explosives consists of mixtures of the first and second groups, in which a body susceptible to detonation, and generally of an oxidizing character, is exploded and the products made to act upon a combustible.

Westfalit, which has just been contrasted with the rest of the Sprengel explosives, is an admirable example of this group, but the most important member is carbonite, which consists of a mixture of about 25 parts of nitro-glycerine, 30 parts of nitrate of potassium, 4 parts of nitrate of barium, 40 parts of wood-meal, and 1 part of carbonate of sodium. On detonation, the nitro-glycerine is decomposed and combustion of the wood-meal at the expense of some of the oxygen of the nitro-glycerine and the metallic nitrates takes place. There is no doubt that the admixture of so large a proportion of carbonaceous material reduces the temperature of the explosion, but it also makes it one of the worst offenders as regards the generation of combustible products, and if carbonite be exploded in an experimental bomb, the escaping gases can be ignited and will burn with a characteristic carbon monoxide flame, over 40 per cent. of the products of its combustion consisting of this gas.

So far, carbonite has come out in trials and in practice in a very satisfactory manner, but a blown-out shot in a dusty mine would be quite likely to lead to an explosion, whilst the fumes must be very injurious to health.

For the reasons which the writer has brought before the members, he thinks that the selection of a safety-explosive should be based upon the following points :—

1. The explosion must be due to detonation and not to simple combustion.

2. If the explosive be a mixture, both the combustible and oxidizing material must be susceptible of detonation.

3. The products of explosion must be non-inflammable and non-poisonous.

4. The explosive must be safe in handling as well as in action, and compounds of an unstable character which are liable to change should be avoided.

5. The temperature of explosion should be as low as is compatible with rapidity of action.

The following table gives an idea of how far the explosives most in use comply with these requirements, and it will be seen that the Sprengel explosives occupy the foremost place :—

MINING EXPLOSIVES.

Name.	How Exploded.	Products of Explosion.	
		Combustible.	Non-combustible.
Gunpowder	Combustion	14	86
Blasting powder	"	42	58
Nitro-glycerine	Detonation	nil	100
Nitro-cotton	"	61	39
Gelignite	Detonation and combust'n	7	93
Carbonite	" "	41	59
Roburite	Detonation	nil	100
Ammonite	"	nil	100
Bellite	"	nil	100
Securite	"	trace	100
Blasting-gelatine	"	46	54
Tonite	Detonation and combust'n	8	92
Westfalit	" "	trace	100

Given an explosive which answers to these requirements, and using electric firing with detonators containing sufficient fulminate to ensure complete detonation, accidents from explosives ought to be reduced to a minimum.

The Preservation of Mine Buildings.

Mine owners and mine managers are gradually adopting the plan of painting breakers, tipples, engine houses, boiler houses, and all other buildings connected with mines.

The prime object of this painting is the preservation of the lumber, and the added neatness given the plant. The cost of applying the paint is at least as great as the cost of the paint itself, therefore it is good economy to use only a paint of recognized merit, and one that combines the most good qualities. It does not cost any more to apply such a paint than it does to apply a poor quality.

The manufacture of paints has kept pace with other industries, and to-day paint can be obtained which not only possesses all the essential paint qualities, such as covering capacity, beauty of finish, lasting quality, etc., but which also has the property of enormously limiting the combustibility of wood to which it is applied, and consequently will resist fire, where formerly paint would increase the combustibility. These paints, furthermore, cost no more than good ordinary paints, such as our grandfathers used.

The value of fire-resisting paint can be readily understood, for while it serves every purpose for which it is designed, it is an *absolutely automatic* fire extinguisher, as it is not necessary, as is the case with buckets and hose, to have someone on hand to extinguish the fire, but as soon as the flames reach the paint they will die out for want of fuel.

The Jamieson Fire-Resisting Paint, made by the Jamieson Fire-Resisting Paint Co., of 62 and 64 William St., New York, is an especially good paint for mine use. It has been on the market long enough to establish all claims made for it, and its fire-resisting qualities are of a high order.

Novel Plans for River Gold Mining.

A highly interesting and ingenious method of river gold mining has recently been evolved by Mr. Charles Bell, of St. Leonards, whose name readily recurs to the mind in connection with this important, but comparatively little-known, branch of activity. The method in question is best illustrated by a description, necessarily brief and fragmentary, of the plant recently manufactured in a north-country town to carry out Mr. Bell's idea. The apparatus in question, if so it may be called, consists of a floating pontoon, 70 feet long by 25 feet broad, 5 feet deep in the middle, and drawing at work about 2 feet 4 inches. In the centre is a well, inside of which moves up and down a cylinder 2 feet 6 inches in diameter; and at the bottom there is a working chamber 6 feet in diameter and 7 feet in height, and at the top an air tight door. When the cylinder is lowered towards the bed of the river—its upper rim being kept at a height of more than a foot above water level—a workman enters, and the water is gradually forced out by means of compressed air. At length the bottom of the cylinder rests on the bed of the river, and the operator is able to proceed with his work dry-shod, and by the aid of electric light. The sediment on the river bottom is raised to the sluice-boxes by suction-pipes working either inside or just beyond the edge of the cylinder. The boxes retain the gold and reject the gravel, &c., into the river behind the dredger. This is the ideal theory of the process, and if, in practice, it only works out fairly successfully, a distinct advance will have been made in the methods of river mining. In any case we shall watch the further development of this novel and improved application of an old principle with considerable interest.—*Mining Journal, London.*

PROSPECTING FOR GOLD.

GOLD PLACERS; HOW THEY ARE WORKED.

Theories of the Origin of Gold Sands and the History and Distribution of Gold Placer Deposits Throughout the World.

Written for THE COLLIERY ENGINEER AND METAL MINER by Prof. Arthur Lakes.

In these days, when all the world is after gold, any information as to where to find it and how it is extracted and mined is of interest. In former articles we have given some account of its occurrence in veins, how to prospect for these, and how they are mined. We have also given some account of placer mining and cited one or two typical examples. Now we propose to give in succeeding articles a full history of placer deposits and their mode of exploitation. Placer mining will, we predict, soon come more and more to the front. Although in early times it was the only kind of gold mining, yet for a long interval it has been thrown in the shade by the discovery of gold veins in place. The prospect of getting suddenly rich on these and striking a bonanza caused the more steady, regular and less exciting work of placer mining to be in a measure laid aside. Now gold in any form or condition and in any sort of place or circumstance will be sought for, and we predict that more attention than ever will be given to these humbler deposits.

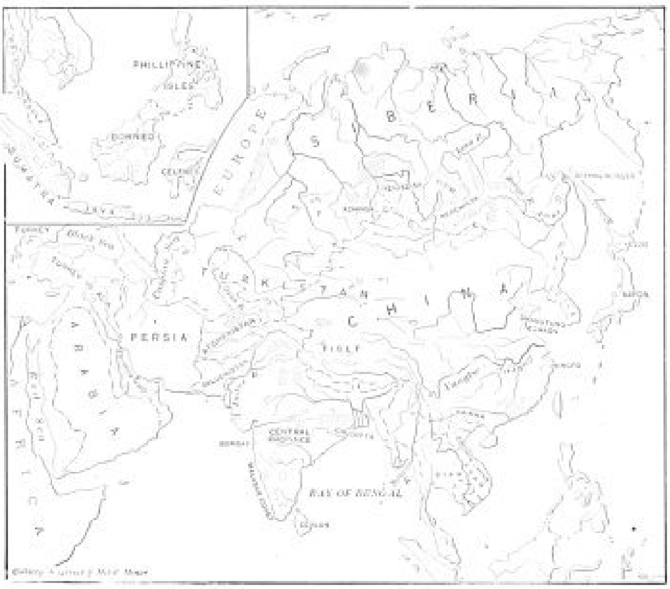
In Colorado the signs of this are already apparent. Old, abandoned placers that were just skimmed over by the old-timers of '59 are being reexamined and efforts on a large scale made to reach down to bed rock, which the "old-timer," with his simple appliances, never dreamed of doing. New tracts of placer ground are being taken up and long lines of ditches constructed for bringing water to bear on placer deposits which were never touched in the old days, because there was no water at hand. New schemes on large scales are being started, and with the newest and most approved appliances, like the placer at Roscoe familiar to our readers. Besides going down to bed rock in river beds whose dry banks were just skimmed by the prospector with his little sluice and Chinese wheel, the water of the rivers themselves is being turned from its natural course, exposing long reaches of river bed and entirely new and virgin ground, and this ground is being worked down to bed rock, though it be 50 or 60 feet deep, by deep and continuous trenches with the help of giant nozzles and Ludlum elevators and approved series of undercurrent sluices. The old-timer with his "Long Tom" or "rocker," and his little squirt of hose pipe would look on in amazement at great 30-inch stave pipes and giant nozzles and Ludlum elevators and sluice after sluice in long succession.

Placer mining is the earliest form of gold mining known. All the gold of the ancients was obtained by some sort of simple placer mining, in most cases from the sands of flowing rivers. The gold of Ophir that made Solomon so rich was extracted by washing river sands. The gold of the Aztecs and Indians was all derived from the same source. The ancients never seem to have thought of looking for or working leads in place. Even their tin, which was procured so abundantly by the Phenecians and so much used in making bronze implements, was derived from surface washings or "stream tin," and their extensive surface placers are visible in Great Britain at this day. It was not till quite a late date in the world's history that gold leads in place were looked for and mined. Even in our own country the old prospectors of '59 were all placer miners, all gold washers, relying more on their pan than on their pick, and it was not till some time after gold was discovered at Sutter's Mill, in California, and an elaborate system of placer mining established, that the miner bethought him of looking up the localities where all this gold might come from, and found leads of gold and silver in place and developed them.

Placer mining or gold washing on a small or large scale is being and has been carried on in nearly every country of the known world, even in countries not generally considered as carrying gold veins in place. Every great river of the world has been more or less worked for gold, and even the sands of the sea beach.

ORIGIN OF GOLD SANDS.

And here let me correct what I believe to be a popular mistake, and that is, it is supposed that all gold must originally occur in veins and that all gold found in placers and in the sands of rivers must at one time or other have been derived from the breaking up of such veins by glaciers and the winnowing of the material by streams and floods. I do not think this is entirely or in a large part the case. It is very certain that many placer deposits derive their gold from such veins, but by no means all; still less the amount distributed over the rivers of the world in regions not remarkable for gold-bearing veins. I believe that gold is concentrated in veins, but is widely and perhaps minutely distributed also through the rocks themselves, more especially the granitic and igneous rocks, lavas, porphyries, etc. If we could break up and mill as glaciers and erosion have done, whole mountains of granite, we should undoubtedly find a small residium of gold irrespective of quartz veins. Many of our lavas in Colorado, especially those known as andesites and rhyolites or porphyries, if ground down, will yield gold, and often even on a small scale will assay in gold. In the Cripple Creek region, which is covered with a dense mass of andesite and phonolite lavas, the gold is by no means found to be restricted to so-called veins, but almost any piece of lava picked up at random will assay in gold and sometimes even as high as $25. Nor in the so-called veins or in the mines is the gold found restricted to orthodox quartz veins or veins of any kind, or even to fissures of any kind, but quite often it is diffused through the substance of the lava along a certain broad zone or in a dyke penetrating previous flows of andesite lava. In some cases large masses of rotten, honey-combed granite are shipped as ore, being thoroughly permeated with ore matter. Again, at Leadville, in the Little Johnnie and Ibex, in the great gold belt, as it is called, the gold is by no means in veins, but permeates a thick mass or belt of decomposed pyritiferous porphyry, quite one of the leading rocks composing the structure of the Leadville region. Supposing, now, a glacier, followed by streams, to break up and winnow whole mountain sides of such porphyry, we might readily account for the gold placers formed from such, and by no means think of attributing the gold to gold veins in place. The same may be said of many other crystalline rocks, and if Sandberger's lateral secretion theory has any weight, most crystalline rocks contain in these elemental crystals and minerals minute portions of gold as well as of the other metals. In experience in the West it will be found that by far the largest and most important gold mines are decomposed dykes impregnated with gold, and in other rocks the expert is often sorely put to it to define his ore body, as there is no visible vein in place, but the ore-yielding body is an indefinite impregnation of the country rock along certain not sharply defined zones. To the breaking up of granite and other mountain ranges over the earth's surface by the wear and tear of erosion and time, we attribute in most cases the gold found far and wide in rivers, though possibly a mythical Pactolus river flowing golden sands may derive its extraordinary wealth from gold veins not far distant.



DRAINAGE MAP OF ASIA; DOTTED LINES SHOW LOCATION OF GOLD DEPOSITS.

THE HISTORY AND DISTRIBUTION OF GOLD PLACER DEPOSITS OVER THE WORLD.

Among the early records of gold washing we learn that the Greeks from the earliest times carried on an extensive commercial intercourse with the people who lived north and east of the Black Sea, and drew largely on the gold fields of Siberia, from which source the Gothic tribe of the Massagetoe also obtained their wealth. These gold deposits are supposed to have been situated in latitude 53° to 55° North and are said to be identical with those worked by the Russians during the present century. In Asia Minor the mountains and streams of Phrygia and Lydia yielded gold in ancient times, and there was supposed to be, according to Herodotus, the wonderful Pactolus river, from whose golden sands Croesus is said to have derived his wealth. The sands of Asia Minor, however, have long since ceased to yield the precious metal.

Strabo says that imperial Rome was inundated with a glut of gold from her northern mountains, the Alps. (These mountains, be it said, are largely composed of granite and other crystalline rocks.) Polybius says that in his times gold mines were so rich about Aquileia * * * that if you dug but two feet below the surface you found gold, and that the diggings generally were not deeper than fifteen feet. * * * Italians aiding the barbarians in the working for two months, gold became forthwith one-third cheaper over the whole of Italy. Gold alluvia occur in various localities in upper Italy, but appear to be poor, and at the present time no gold-washing is carried on except by a few individual workers. The sands of the Orco, the Jassin, the Po and Serio are estimated to have yielded 300 ounces gold in 1862. In Spain and France the Romans are stated to have washed the sands of streams along the base of the Pyrenees, which are also composed of crystalline rocks.

The Phenecians obtained gold from the bed of the river Tagus 1100 B. C., and washings are reported along this stream as late as 1883 A. D. The Douro sands were worked for gold by the Arabs until 1147 A. D. Up to the close of the fifteenth century the deposits of the Ariege yielded annually about 100 pounds of the precious metal. As late as 1846 gold washings are reported along the Rhine between Strassburg and Philipsburg. (It is worth noting that all these rivers mentioned have their sources in, or drain regions of crystalline rock.)

DRAINAGE MAP OF EUROPE; DOTTED PORTIONS SHOW LOCATION OF GOLD DEPOSITS.

In Africa the ancient Egyptians mined the precious metal in Nubia, and there are mines extant between Berenice and Suakim on the Red Sea. These are spoken of by Diodorus Siculus, and shown on one of the oldest topographical maps extant, preserved in Tunis.

The earliest record of the Egyptian mines dates from the twelfth dynasty, and those of Kordofan, in Abyssinia, are mentioned by Herodotus.

That crystalline rocks exist in these regions is shown by the great monoliths that have been dug up, many of which are of red crystalline syenite, a rock very like red granite. In fact, a very large portion of the continent of Africa is of granite, hence it has been claimed as one of the oldest countries geologically in the world.

Nearly all the gold obtained in Africa till within the past few years has been from alluvial deposits. The country south of the desert of Sarah contains numerous gold-bearing alluvions worked by negroes. The product is conveyed by caravans to Morocco and Algiers as a principal article of export from the Guinea coasts. Gold dust was also obtained on the southeast coast opposite Madagascar, in the country of Sofala, where by some is supposed to be the region whence Solomon obtained his wealth. Of the diggings in the past few years in the Transvaal and Leydenburg district, where coarse nuggets weighing as much as 11 pounds have been found, we will speak later. The gold export of all Africa from 1493 to 1875 is estimated at £106,857,000. In India, in the Bombay presidency, gold-bearing deposits exist in the district of Belgaum, Dharwar and in the Mahratta country. The sands of the Surtar are gold-bearing also. The central provinces of India contain many small deposits of gold, but the number of gold washings is comparatively limited. The ancient gold mines of Madras have been rediscovered. The great wealth of the nabobs of India is supposed to have come from these mines and from Malabar. Regions are in places covered with tailings showing the industry of some of the ancient tribes. Gold quartz is being mined in different parts of the province of Mysore. A number of rivers having their sources in the State of Travancori contain gold-bearing sands and gold washing is carried on in these places at the commencement and termination of the rains, just as in Colorado at the beginning of spring and in most of our western states, with the close of winter to its commencement again, for placer mining is a summer occupation and dependent on the openness or freezing up of its water supply. The sands of the streams of Ceylon, the Philippine Isles and the Indian Archipelago carry gold. At Borneo there has been extensive mining by the Chinese and natives, over 30,000 of the former being now employed in the gold fields. (We may note here that the rocks of these islands are for the most part volcanic and crystalline and the whole archipelago is more or less volcanic.)

In the seventh century the Chinese traveler Hiuen-thsang describes the country north of Kuen-Lun toward the desert of Gobi as a gold-bearing district. Somewhere in this district Humboldt locates the land of gold sand spoken of by the Dardai. Pumpelly states that

Map of Africa; Dotted Portions Show Gold Deposits.

gold is found in fourteen out of eighteen provinces of the empire. The greatest number of washings is in the province of Se Chuen, also the Kuen-Lun mountains penetrating central China. Placers are not uncommon yielding coarse gold. Hundreds of thousands of natives work the sands of the river Kinsha Kiang. (That placer mining to "John" is no new business is evident from the ready way in which he takes hold of our western placers and manages to get both gold and wages where no white man can.)

In Japan gold was first discovered in 749 A. D., and the art of mining is said to have been introduced from China. Marco Polo in the thirteenth century says of Japan: "They had gold in the greatest abundance, its sources being inexhaustible." The Portuguese between 1550-1639 exported 300,000,000 dollars in gold, till the Japanese government forbade further export. The deposits were mostly shallow placers. The gravel beds are of river origin, limited in extent and uniformly poor. The richest deposits near Yesso contain less than 7 cents per cubic yard and the average of the best does not exceed 5½ cents.

Russia has extensive gold-bearing deposits and in these northern regions we may expect that many of them were laid down through the agency of ancient glaciers as well as by modern rivers. The principal mining districts are those of the Ural, the Altai region in western Siberia, western Turkestan, the northern and southern Yeniseisk fields, the circuit of Atchinsk, Irkutsk, the basin of the Lena and the country along the Amur and Nerchinsk. The total yield of gold washing from 1814 to 1860 amounted to 35,487 poods or 1,548,661 pounds Troy of alloyed gold. From 1753 to 1876, $730,000,000. The gold fields of the Ural extend 600 miles north to the Arctic ocean and south to the Cossack districts. The districts of Miask and Kashgar are the richest. At the former the largest nuggets have been found and at the latter emeralds and pink topazes associated with gold. The whole eastern slope of the Ural is gold-bearing. The first washings were commenced in 1814. In the southern Ural the rivers are remarkable for their minerals and precious stones. (It is not uncommon to find gems and precious stones in the tailings of placers. Quite a number of diamonds have been so found. Garnets are exceedingly common. Rubies, too, are found, and many other heavy crystals and gems characteristic of crystalline rocks.) The Altai region in Siberia was early discovered. On the Yenashimo river very productive placers were found, although the gravel was but 10 feet deep but 700 feet wide. They work from May to September. In some districts there is a scarcity of water. In the great Pit river, 250 miles long, the valley is 3,000 feet wide. The river in places is very rapid and narrow. The pay in places is confined to a channel 56 to 100 feet wide and 12 feet deep. Rubies, zircons and tourmalines are found. On some of the most promising grounds on the Lena the climate is very severe and the ground frozen the entire year. (In Alaska they break out large blocks of frozen ground and thaw or pound the gold out of it.)

(To be Continued.)

MINE FIRE EXTINGUISHED.

A Fire in Port Royal Mine at Port Royal, Pa., Extinguished by Successfully Cutting Off the Air from the Burning Portion.

Written for The Colliery Engineer and Metal Miner by H. E. Gray.

Port Royal Mine is situated in the Ninth Bituminous District of Pennsylvania, and the coal worked is the "nine feet semi-bituminous seam." It is worked by the pillar and chamber method. The ventilation, which is at all times ample, is produced by large blowing fans, the whole current being divided into two main splits.

The plant is owned and operated by the Port Royal Coal and Coke Co., of Youngstown, Ohio. It is well equipped with all the latest and most approved machinery. The under-cutting of the coal is done by the Jeffrey air power mining machine. The holes for blasting are made by the Jeffrey Giant air power coal drill. A large compressor manufactured by the Norwalk Iron Works Co. of South Norwalk, Conn., furnishes the power required in the mine for all machinery including the pumps. When the machinery is all in motion the exhaust air materially assists the ventilation. The coal mined is very gaseous and it requires considerable care on the part of the miners when using explosives, to prevent the flames from the powder igniting the gases given off from the freshly blasted coal.

Some time ago, by the carelessness of a miner, a fire was started at the working face of No. 16 butt entry, and it had made such rapid progress and covered such a large area when discovered, that the ordinary methods of dealing with such fires were of no avail. Temporary stoppings of suitable material were hastily thrown up and later substantial stoppings of brick and stone were erected, the object being to exclude all air from the fire. An iron pipe fitted with a valve was placed in each stopping and tests were made from time to time of the gases which flowed out when the valves were opened. It was finally concluded from tests made at the mouths of the pipes, that the fire was extinct.

The mine was safely operated from the time the fire was first discovered, except a few days during which time the stoppings were being erected, and not a single accident has occurred.

On Saturday, January 4th, at 5 p. m., after all the workmen had left the mine, a party of explorers headed by the mine foreman, descended No. 1 shaft and proceeded to the stoppings already mentioned. Two fire bosses were sent to examine the workings and also to see that every workman was out of the mine. As soon as they returned and reported all safe, work was commenced on the brick and cement and soon air was moving into Nos. 16 and 17 butt entries for the first time in about five months. Two of the exploring party soon followed in the direction of the air current and in a short time all were able to reach the working face of No. 17 entry. There we found the entries almost closed with fallen strata, and we could scarcely crawl over the falls to No. 16 entry. The opening was not sufficient for good ventilation, so the men went at it systematically and soon removed enough stone to allow a sufficient opening for air.

Meanwhile, the ventilating current was efficiently doing its work, and by 11 p. m. a continuous current of air was passing through both entries. We found that the fire was entirely extinguished, and there was not the slightest indication of heat anywhere.

I examined the territory to endeavor to learn the extent of the fire. I found charred coal, coke and ashes scattered profusely in all directions. Canvas hanging on posts was crisp, charred and blackened by the fire, and if touched by the hand, it fell in dust to the floor. Everywhere it was clearly demonstrated that the fire had been on a large scale. Many mining authorities assert that a mine fire cannot be successfully extinguished by the method described. That it has been a success in this instance cannot be denied. Its extinguishment reflects great credit on the management of the mine, and more especially on the mine foreman for the careful and scientific manner in which he conducted the whole enterprise to a successful termination.

WOODEN WATER PIPE.

Its Advantages Over Iron Pipe for Use in and About Mines.

The wooden water pipe (patented) made by Messrs. Ayrault Bros. & Co., of Tonawanda, New York, is worthy the attention of mine owners and mine managers. Owing to its non-corrosive qualities it is the best type of pipe for use as column pipe under moderate heads. As water supply pipe it cannot be excelled, as it is practically indestructible for such service if properly protected from freezing. It is made from first growth Michigan pine, with the sap entirely turned off. Ordinary wooden water pipes will not meet the requirements for two reasons:—First, they will rot on the outside, in some kinds of soil. Second, they are not strong enough to sustain the pressure they are generally subjected to.

These deficiencies are overcome in the pipe manufactured by Messrs. Ayrault and brothers in the following manner:—

Imperishable cement is applied to the outside of each section of pipe after the sap is removed from the timber, thus protecting it from the action of the soil, and effectually obviating the first objection, as given above, to the common pump logs. The second deficiency is supplied by spirally winding the pipe with iron before coating, so as to make it sufficiently strong to sustain any ordinary necessary pressure.

As a water pipe it possesses the following advantages:—

(1) It is cheaper than iron; (2) it is more durable; (3) it can be laid for less money; (4) service connections are more easily made; (5) it better maintains the purity of the water; (6) mineral water will not corrode or destroy it; (7) cost of repairs is much less; (8) it is not so liable to freeze; (9) if frozen, the elasticity of the timber in the pipe allows the action of the frost without injury; (10) this quality renders it less liable to burst from hammer action of pump or hydrant; (11) no section of pipe has been known to be so weak that 80 lbs. pressure could not be kept on the line in case of fire; (12) its weight being much less than iron, freighting it is much cheaper.

As a column pipe its advantages are practically enumerated above.

Messrs. Ayrault Bros. & Co. issue a neat illustrated catalogue that describes the pipe more fully than can be done in such a notice as this. They will cheerfully send a copy to any mine owner or mine manager.

Garlock's Water-Proof Hydraulic Packings.

The constant demand for a superior packing for the plungers and pistons of pumps, induced the manufacturers of the Garlock packings to produce a packing which would meet all requirements. After many years of experiments and at a considerable expense, they have succeeded in producing a water-proof hydraulic packing which they claim is sure to answer all purposes. This packing is the outcome of numerous experiments and practical tests in the water end of pumps, hydraulic elevators and hydraulic machinery, with results that fully justify their claim that they have produced a first-class water-proof packing for light or heavy duty, made of the best flax, and thoroughly lubricated with a water-proof compound which is strictly free from acid. This packing is made in all sizes up to two inches.

Garlock's Water-Proof Hydraulic Packing.

Heretofore, the best rawhide hydraulic packing answered the purpose well for a time, but soon became water-soaked and soft from the use of oils, losing its strength, and piston plungers were sure to leak badly, requiring constant repacking. This packing is intended to resist excessive pressures and retain its solidity. One of the principal claims for this packing is that it is absolutely water-proof and oil-proof. Engineers who daily experience the difficulties of leaky pump plungers will no doubt greatly appreciate the advent of this packing.

The Chicago Drainage Canal.

We have received from the Ingersoll-Sergeant Drill Co., of New York, an artistic illustrated pamphlet describing the Chicago Drainage Canal, which ranks among the leading engineering projects of the century. The book contains much interesting data concerning the canal, and while intended to show the success attending the use of Ingersoll-Sergeant air compressors and drills, it is not merely an advertising catalogue. The views given show various mechanical contrivances used on the work, and, therefore, illustrates the productions of other manufacturers as well as those of the publishers. It is a pamphlet that will be read with interest by every person interested in excavating, quarrying or mining. It will be sent free to any address on application to The Ingersoll-Sergeant Drill Co., Havemeyer Building, New York.

The Westinghouse Electric and Manufacturing Company of Pittsburg has received a number of awards at the Atlanta Exposition for the handsome exhibit of electrical apparatus made. Several gold and silver medals are among them.

ELECTRIC MINING MACHINERY.

Electric Pumps, Fans and Blowers, Showing Latest Electrical Designs.

The operation of mining apparatus by electricity is daily growing more widespread as the steady work of the plants now running drives home the conviction that by means of electricity mines may often be operated more conveniently than by any other system, better work be effected and greater economy induced. Coal and metal mine operators are animated by no sentimental inclination in favor of older methods. It is simply a question with them of an outlay and resultant profits and the electrically driven apparatus is in many fields slowly, but effectually, displacing apparatus operated by steam or compressed air.

Of all the companies manufacturing electric mining apparatus, the General Electric Company has, perhaps, more than any other, contributed to the bringing about of this result. Since it first entered the field, it has kept steadily in view the improvement of its electrically operated mining apparatus and its adaptation to the peculiar conditions of the mining industry. The illustrations show a few examples of apparatus produced at its works and now in successful operation.

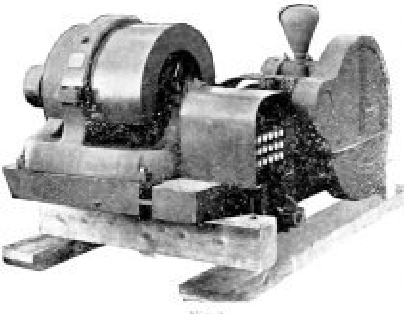


Fig. 1.

Fig. 1 shows a 6½ inch by 8 inch horizontal triplex pump, directly driven by a 10 H. P. four pole, slow speed motor through two reduction gears, the entire combination on the same base, being mounted on a truck for ready transportation from place to place in the mine. The motor is controlled by a rheostat set at the side and, like the motor, housed in with a sheet iron cover. The illustration shows the truck mounted on wooden base for shipment.

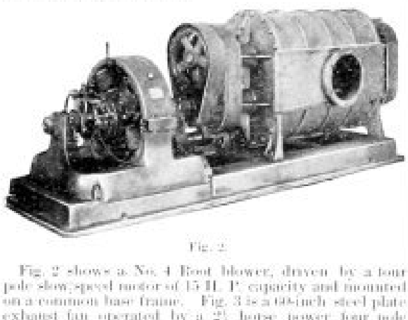


Fig. 2.

Fig. 2 shows a No. 4 Root blower, driven by a four pole slow-speed motor of 15 H. P. capacity and mounted on a common base frame. Fig. 3 is a 60-inch steel plate exhaust fan operated by a 2½ horse power four pole motor. The fan makes 480 revolutions per minute and has a capacity of 8,300 cubic feet of air per minute at ¾ inch W. G.

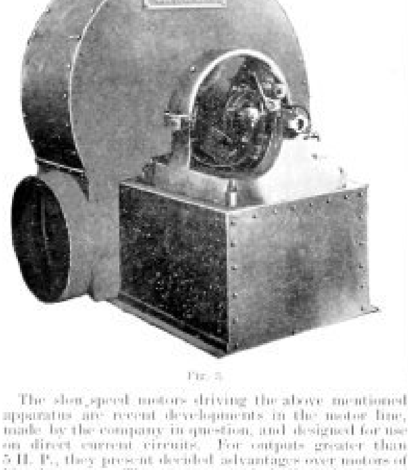


Fig. 3.

The slow-speed motors driving the above mentioned apparatus are recent developments in the motor line, made by the company in question, and designed for use on direct current circuits. For outputs greater than 5 H. P., they present decided advantages over motors of bi-polar types. They are compactly built and admit of direct combination with machinery without increasing the space occupied to any great extent. They operate at slower speed than any other motors of similar capacity yet built, and although reduction of speed must necessarily imply increase of weight, yet in this case it is amply compensated for by economy of material effected by the adoption of the four-pole type. The frames and fields are of special soft cast steel, which, possessing high magnetic permeability, allows the construction of a motor lighter than other motors of the same output at higher speed. The armatures are thoroughly ventilated; and the windings of copper wire, first formed and insulated, are embedded in slots in the armature core, and bound down securely on the projecting flange of the armature spider. The coils can be easily removed and replaced; the insulation is the excellent result of years of experience. The machines are sparkless and the load can be varied from nothing to full load without the necessity of shifting the brushes. Precautions are taken to prevent any tendency on the part of the bearings to get out of alignment and proper contact of brushes with the commutator is insured by special construction of the brush holders.

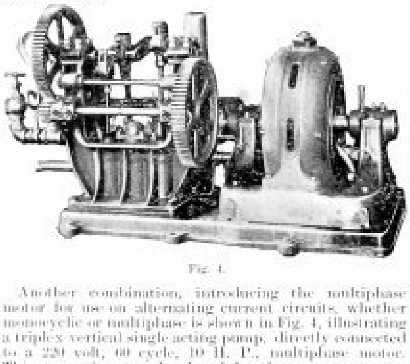


Fig. 4.

Another combination, introducing the multiphase motor for use on alternating current circuits, whether monocyclic or multiphase is shown in Fig. 4, illustrating a triplex vertical single acting pump, directly connected to a 220 volt, 60 cycle, 10 H. P., multiphase motor. This type of motor developed by the same company, aside from its compactness, which allows of its erection in a restricted space, has the additional advantage of being absolutely without brushes, commutator or moving wires. It requires no attention and may be stopped and started under full load or no load; in fact it has all the advantages of the best type of direct current motors, with better regulation and without any of the disadvantages which the presence of commutators, brushes and a wire-wound armature may develop. These motors are now in use on all the three phase monocyclic power transmission circuits in this country, operating without attention and without accident and to the entire satisfaction of the user.

IRON ORE MINING.

Systems of Mining Used in Minnesota Iron Mines.

(By Charles Dean Wilkinson.)

[From the Year Book of the Society of Engineers, University of Minnesota.]

The iron mines of Minnesota may be divided into two general classes according to the condition of the deposit.

I. Mines in which stripping will pay:

II. Mines in which stripping is not possible or will not pay.

The dividing line of these two classes is determined by a rule formulated by Mr. Denton, engineer of the Soudan mine at Tower:

"Stripping will pay when the volume of the ore is equal to, or greater than, the volume of the material to be stripped." It must be noticed that volume and not depth is considered in this rule.

The first class comprises:

A. Mines in which the deposit is thin and covers a large area;

B. Mines in which the deposit is thicker and covers a more restricted area.

The second class comprises:

C. Mines in which there is a poor hanging wall, especially where the deposit is directly under glacial drift;

D. Mines which have a good hanging wall, or in which the deposit is at a great depth.

These divisions merge into one another, as for example the first general division into the second, or *A* into *B*, etc.

The systems applied to each of these conditions of deposit are as follows:

To *A*. Open-cut mining with steam shovel as in the Oliver mine.

To *B*. The "milling" system as used in the Auburn mine.

To *C*. The "caving" system as used in the Canton mine.

To *D*. The ordinary system of "stoping-out" as used in the Minnesota mine at Tower.

Mining by these different systems is carried on as follows:

First, open-cut mining with steam shovels.

The exploration preliminary to the location of mines on the Mesabi range is generally carried on by means of test-pits until the ore is reached. After striking the ore, investigation as to its general quality, the thickness of the deposit, etc., may be carried on with diamond drills.

When the location has been made the stripping is done either by steam shovels or by hand. The larger number of mines do the stripping by steam shovel, but where many bowlders are encountered, as in the Biwabik, it may be necessary to do the work by hand. While ore is being taken out benches must be left around the edges of the area already stripped, for the operation of the stripping shovels.

In removing the ore if the deposit is very soft the shovels may work directly into it, but if the ore is hard it must be loosened by blasts and loaded into the cars by the shovel. The working as carried forward gradually slopes downward, so that a great depth may be obtained without making the gradient of the tracks too heavy. The ore is loaded directly into cars by the shovel and the cars for one shovel may be handled by a single locomotive. The crew for a shovel consists of an engineer, crane-man and helper. The claim is made that a good shovel and locomotive can load and dispose of a 20-ton carload of ore every six minutes. This estimate is approximately true.

This system is peculiar to the Mesabi range and to some of the workings in the Alabama iron regions.

Second, the "milling" system.

Exploration and stripping for mines operated on the "milling" system is carried on in the same manner as for the steam shovel method.

When the deposit is stripped, a shaft is sunk at one side deep enough to run in a level to the lowest point of the ore. Another shaft is sunk to connect with the end of this level and at the bottom an ore-chute is placed. Blasts are now fired around the mouth of this second shaft in such positions that the loosened material will fall to the bottom into the ore-chute. In the Auburn mine the ore is trammed from this chute to the main shaft, the haulage being done by mules. The material is hoisted by skips and dumped either into small cars and conveyed to the stock piles, or loaded directly into the railroad cars.

As the work proceeds radially outward from the secondary shaft the hole presents the form of a volcanic crater. The men doing the drilling for the shots are suspended from the edge by ropes and the blasts are fired at change of shifts.

The only level driven is the one which connects the main shaft with the ore-chute, and the only timbers necessary are the pit frame, shaft-timbers of the main shaft and the level timbers.

With a correct gradient, gravity haulage may be substituted for mule haulage in the level.

The "milling" system is peculiar to the Mesabi range and was first introduced at the Berringer mine by Dr. J. A. Crowell and Mr. F. R. Whittelsey.

Third, the caving system.

Where the overlying material is too thick to strip and not firm enough to furnish a good roof for ordinary stoping out, it is necessary to use another system of mining, and this is provided in the "caving" system as used in the Canton mine at Biwabik and in part of the Chandler mine at Ely.

In operation the shaft is sunk and the top level driven first. At the extreme end of the level a room is cut out and the roof supported by light timbers or pillars of ore. When all the material from the room has been excavated, the pillars are "robbed" and the roof allowed to cave. The next room is then taken out, and so on till the level is completed. Then the second level is treated in the same manner. If the roof in any case refuses to cave, blasts are placed at the four corners and fired simultaneously. After caving, the material thus brought down may be excavated. Thus when the bottom of the deposit is reached there is nothing left but the glacial drift or other overburden. Trouble is often caused in mines operated on this system, by matting or wedging of timbers after caving down one or two levels, so that the roof will not fall.

Fourth, "stoping-out" system. Most of the work on the Vermillion range is carried on by means of the ordinary system of stoping-out.

The Minnesota or Soudan mine furnishes the best example of this system, as it has been the longest in operation and has the most finely equipped plant.

The exploration is done with diamond drills and after the deposit is located a shaft is sunk to the lowest part. Cross-cuts are run in for about 100 feet. From the ends of the cross-cuts, levels are run at right angles to them, as far as the ends of the deposit. Beginning at the end, the material is taken out by overhand stoping. The ore is milled to the level below, mills being provided at short intervals. The space opened is filled with broken country rock taken from the side walls or brought in from outside. A permanent roadway is left at the bottom of the level and is timbered with sets consisting of two posts and a cap, no sills being necessary. Round lagging is used. No other timbers are necessary in the levels as the hanging wall is very strong.

Ore-chutes are provided at the bottoms of the mills and open into the permanent roadway. The ore is trammed to the shaft by men and hoisted in cages. Both percussion and diamond drills are used in drilling for blasts. This use of the diamond drill for blast holes is peculiar to the Minnesota mine. Two roof holes running nearly parallel to the level are put in at opposite sides of the level and meet to form a V. The holes are about thirty feet long and are loaded with thirty pounds of dynamite which fills the hole to about two-thirds of its length. The two shots are fired simultaneously and bring down an immense amount of ore.

The following comparison of systems may be stated. That the open-cut steam shovel method is the cheapest for shallow deposits where the stripping is thin, cannot be questioned. However, when the deposit becomes thicker, the milling system would seem the more efficient for two special reasons: First, if the ore body contains much water it will be necessary to drive shafts and tunnels for drainage, and such tunnels and shafts once driven, the milling system will be cheaper. Second, as the working goes deeper and deeper the gradient of the railroad track becomes heavier and heavier until the engines will have great difficulty in hauling out trains.

The first of these reasons has much weight, as nearly all the Mesabi mines are very wet at the lower levels, and the second, because a steam shovel and a locomotive are both machines of poor efficiency when compared with the results obtained from strong, well constructed and proportioned stationary engines, such as are used for winding in the milling mines.

The last two systems are the product of well defined conditions. To the present time no better methods have been found for such mining. They are certainly more costly than the open cut and milling systems, but with high grade ores and fair prices, can be operated with profit. The permanent plant necessary including winding engines, compressor plant, machine shops, shaft-houses, pit-frames, pumping engines, and possibly crushers for hard ore mines, must be considered in comparing the cost of the systems.

The open-cut mine with its machinery consisting of two or three steam shovels, a locomotive, a small pumping engine, compressor plant if necessary, and a repair shop, certainly has the advantage as to first cost. The question remaining to be answered is, how will the expenses of operating compare. This can be answered when some of the open-cut mines have worked out a deposit.

LEGAL DECISIONS ON MINING QUESTIONS.

(Reported for THE COLLIERY ENGINEER AND METAL MINER.)

Location of Mining Claim in Another's Name.—The Supreme Court of California says that where one, acting under the statutes of the United States, vesting in a locator of a mining claim the exclusive right to its possession, locates and has a mining claim recorded in another's name, the legal title thus vested in the other cannot be defeated by a subsequent parol agreement that it is to be held by him in trust.

Moore v. Hammerslag, 41 Pacific Reporter, 805.

Sale by One Cotenant of Mining Lands.—The Supreme Court of Pennsylvania says that the terms of a contract of sale by which one cotenant of mining lands disposed of his interest will not bind the others to accept the royalty reserved by such sale as a fair measure of their rights. It also held that such purchaser should not be enjoined from mining, but that an account should be kept of the coal mined, and that he should pay into the hands of a receiver twice that reserved by the contract to be paid, until the values could be determined.

Mercur v. State Line & S. R. Co., 32 Atlantic Rep., 1126.

Homestead Right Royalty from Coal Mined Under.—The Court of Civil Appeals of Texas holds that royalty due a homesteader from coal mined on the homestead is subject to his debts.

Collins Mfg. Co. v. Carr, 32 S. W. Reporter, 336.

Negligence of Employer.—It is not negligence, of itself, for an employe to warm his hands in cold weather at a fire where dynamite is being thawed, where there is evidence that the fire was built for the purpose of allowing the employes to warm themselves, as well as thawing the dynamite, and that the employer knew that his men were so using the fire.

In thawing dynamite such reasonable care is required of the employer as is commensurate with the danger that may be apprehended from such use and such ordinary care as reasonable and prudent men under like circumstances use in thawing such material. This kind of care must be ascertained by the general usages of the business, as "ordinary" care must depend upon the peculiar circumstances of each case.

Bertha Zinc Co. v. Martin's Adm'r (Supreme Ct. App. Va.), 22 S. E. Reporter, 869.

Construction of Mining Laws.—Picking rock from the walls of a shaft or outcropping of a ledge, in small quantities, from day to day, and testing it, in order to find paying vein, cannot be credited as part of the $100 worth "of work and improvements" required to be made by the locator on his claim within one year from the date of his location, by the Revised Statutes of the United States.

Bishop v. Baisley (Supreme Ct. Ore.), 41 Pacific Rep., 936.

Negligence of Fellow-Employe in Mine.—A party employed to load ore into cars brought to the floor by the miners. It was the practice, as successive spaces were cleared of ore, to support the roof by timbers put in on notice from the miners, or through the shift boss. Before a newly opened space had been put in condition for the timber men, and before they were notified that their services were required, this party was injured by ore falling from the roof. There was evidence that too large a space had been mined, and that just before the accident the foreman's attention had been called to the roof, and he said it was all right. The Supreme Court of Michigan held that if there was any negligence it was that of a fellow-servant.

Petaja v. Aurora Iron Mining Co., 64 N. W. Reporter, 335.

Laws Applicable to Construction of Mining Lease.—The rights of the parties under a mining lease of land in Pennsylvania must be determined by the laws of that state, though the lease was made at the residence of the parties in another state. The question of how the courts of Pennsylvania have construed mining leases is one of fact, on which the testimony of jurists as experts is admissible, when tried in another state. The courts of New York will not, on a bill to rescind a contract of lease of land in Pennsylvania, decree that a party should remove his machinery from the land and deliver possession of it to the complainant in the suit in New York.

Genet v. President Del. & H. Canal Co. (Superior Ct. N. Y. City), 35 N. Y. S. Rep., 147.

When One May Not Claim Coal.—One who was present at the sale of coal under the surface, and made no objection; nor protested against its being mined for seventeen years, is thereby prevented from claiming title to the coal under an alleged gift, as against such grantee.

Moreland v. Frick Coke Co. (Supreme Ct. Penn.) 32 At. Rep. 634.

Payment of Royalties Without Working Mine.—Where a contract expressly permits the cessation of mining on a parties' land, by providing that if no coal be mined the lessee shall make a payment for a certain number of tons per year, then so long as they make this payment they are entitled to use and enjoy the rights and privileges otherwise granted, and the openings, buildings, fixtures and appurtenances made and constructed for mining, preparing and forwarding coal on the land of the lessor, as well as for mining, preparing and forwarding coal from the adjoining or contiguous lands; where the right to use the land for the mining of coal on adjoining and contiguous land is not limited by the agreement to any particular time, it is to continue until the coal of the contiguous land is exhausted. It does not depend upon the amount of coal taken from the land of the lessor, and the court will not make such construction as will be to make a new contract between the parties.

Genet v. Del. & H. Canal Co. (Superior Ct. N. Y. City) 35 N. Y. S. Rep. 147.

Contributory Negligence.—The law is, that the employer is bound to furnish a reasonably safe place for the employe to work in, and must furnish such information as to dangers latent, or not apparent, as may reasonably put the employe on his guard. Where the locality or the appliance is dangerous, and the means of knowledge are equally within the knowledge of the employe and the employer, the latter is not obliged to take any greater care of the former than he (the employe) does of himself. In an action against a mining company, for injuries, it appeared that there was a walk, made several years before the accident, resting on timbers, and made in the usual way; that it is not customary to repair such walks; that the employe was an experienced timberman, and knew the planks were rotten; that he undertook to walk across one of such planks, when it broke, and he was injured; that it was not necessary for him to cross such plank; and that there were plenty of new planks to be had by him, by asking for them. Even though it should be held that the employer was negligent in not notifying him, or sending some one with him to warn him of the condition of the plank which broke, the evidence shows that the accident occurred through the negligence and rashness of the employe himself, directly contributing to the injury. He had all the knowledge which any one could have as to the general condition of the timbers, and of the probable rottenness or soundness of the planks by which he attempted to cross. The omission to take these ordinary precautions, under the circumstances, was an assumption of the risk involved, and the consequences cannot be thrown upon the employer. He knew that, if the plank happened to be decayed or defective, there was no custom of the employer, or of any mine, to repair it. He knew that he was thrown entirely upon his own discretion and judgment, and could expect nothing on account of any care on the part of the employer. The courts, without hesitation, in all cases like this, deny relief to the party injured.

A contrary rule would make the employer not only an insurer, but an insurer against the recklessness and carelessness of the employe himself.

Cook v. Bullion-Beck and Champion Min. Co. (Supreme Ct. of Utah.) 41 Pac. Rep. 557.

Construction of Mining Contract.—The owners of a mine, which was being worked by a party under an agreement that the ore extracted should be worked in a mill belonging to the mine owners, and the proceeds divided as follows: The mine owners were to be paid $25 per ton for milling; the party working the mine was then to be paid the expense of extracting the ore; and the balance was to be equally divided between him and the owners of the mine. It was held, that these parties were simply tenants in common of the ore and its proceeds, and no partnership existed between them.

Vietti v. Nesbitt. (Supreme Ct. of Nevada.) 41 Pac. Rep. 151.

Duty of Master to Furnish Safe Place to Work.—It is the duty of a mine owner to adopt all reasonable means and precautions to provide a safe place for a miner in which to prosecute his work. A miner engaged in running a tunnel in a mine, under the immediate supervision and direction of the foreman and manager of the mine, is not engaged in creating a place, on his own judgment, and at his own risk. He assumes the risks naturally attendant upon driving a tunnel. It is the duty of the mine owner to keep that part of the tunnel or place already created safe, by whatever reasonable means are necessary. If the miner is injured while in the actual work of drilling or blasting in the face of the tunnel he is driving, he may have no claim for damages; for these are risks he assumed as a miner. But he does not assume the risk of the mine owner's failure to keep that part of the tunnel or place already created reasonably safe and secure.

For instance: If a stone or material blasted or dug from the tunnel by the miner should have blown against, or should have fallen upon him, he would have no remedy against the mine owner for any injury sustained thereby. This is a risk belonging to his employment, and which he assumes. But he does not, by his employment as a miner in driving a tunnel, assume the risk of the failure of the mine owner to take such reasonable precautions as are requisite to prevent the caving and falling of the roof of that part of the tunnel already created, upon him, while engaged in his work. Nor does he assume the risk of the failure of the mine owner to keep the floor of the tunnel so free from rock and debris as not to materially hinder or obstruct his escape from his place of work, in case of accident, which might occur by premature or unexpected explosions of the dangerous materials he is using in his work. He assumes the risks incident to the work in front of him, and not the risks of the failure to properly care for that part of the tunnel or place behind him, which he has completed, and turned over to the care and control of the mine owner.

Kelly v. Fourth of July Min. Co. (Supreme Ct. of Montana.) 41 Pac. Rep. 273.

When Machinery Becomes a Part of the Reality.—Machinery placed in a building and fastened by bolts to a brick foundation thereby becomes a part of the reality, and, with the latter subject to an existing vendor's lien thereon.

Simpson, Hartwell & Stopple v. Masterson. (Court of Civil Appeals of Texas.) 31 S. W. Rep. 419.

Mining Liens.—The statute securing a lien on mining claims for labor performed thereon, does not authorize a lien for labor in working a mine on lands held under an agricultural patent from the United States.

Morse v. DeAdro. (Supreme Ct. of California.) 40 Pac. Rep. 1018.

Mining Partnership.—A partnership agreement to locate mining claims being within the statute of frauds, one partner cannot claim an interest in a claim located by another under an oral agreement that they should be partners in all such locations, when no trust arises because partnership capital was employed in locating the claim. The statute declares: "Sec. 55. No estate or interest in lands other than leases for a term not exceeding one year, nor any trust or power over or concerning lands, or in any manner relating thereto, shall hereafter be created, granted, assigned, surrendered or declared unless by act or operation of law, or by deed or conveyance, in writing, subscribed by the party creating, granting, assigning or declaring the same, or by his lawful agent, thereto authorized in writing." Equitable relief may be given against the partner holding the legal title when the property has been acquired by partnership capital upon the theory that a resultant trust exists, a trust arising by operation of law, and within the exception of the statute.

Craw v. Wilson. (Supreme Ct. of Nevada.) 40 Pac. Rep. 1076.

Construction of Mining Lease With Regard to Royalties.—A joint lease for mining purposes, executed by owners in severality of two adjoining tracts, provided that the lessee should pay as royalty a certain sum monthly to the lessors. One of the lessors subsequently conveyed his separate tract to the lessees. It was held that the remaining lessor was entitled to royalty thereafter in an amount equal to the value of his distinct tract as compared to that conveyed to the lessee. Where the lease provided that the lessee could extract asphaltum from any part of the leased premises, and the share of one lessor was subsequently conveyed to the lessee, it is no defense, in an action by the remaining lessor for royalties, that no asphaltum was taken from his separate tract. Under the statute providing that twenty hundredweight constitute a ton, the words "gross ton," as used in a mining lease as the basis for payment of royalties, means a ton of two thousand pounds. Under a mining lease of a "deposit of bituminous rock," and a "deposit of liquid asphaltum," providing that the lessee should pay a royalty "for each and every gross ton of bituminous rock and liquid asphaltum which he may have mined, taken, or removed" from said premises, the words "mined," "taken," or "removed" were used in the same sense and do not mean that a royalty shall be paid on the basis of the crude rock, or the refined product, after being shipped from the premises. In such a lease, a provision that the lessee should pay a certain royalty per ton on liquid asphalt, applies only to the asphalt taken from the the liquid deposit, and not to liquid asphalt taken from the crude rock.

Higgins v. California Petroleum and Asphalt Co. (Supreme Ct. of California.) 41 Pac. Rep. 1087.

What Constitutes Negligence in Case of Injury to an Employe.—In an action for personal injuries received while blasting rock, testimony was given by the superintendent of the work, that though he had never before had charge of dynamite blasting, he knew how it ought to be done. It was held that this did not show negligence in the selection of a superintendent. Where workmen were drilling a blasting hole, and a charge which one of them did not know was there exploded, he receiving injuries, the evidence showing that the employers had requested the workmen to commence work at five o'clock in the morning of the accident, had directed two men to manipulate the drill because it was too heavy for one, and had sent the workman in charge of the blasting to sharpen tools, supposing the charge in the hole had been exploded, personal negligence on the part of the employers is not shown. One whose duty it is to superintend blasting in a quarry, but who spends most of his time in attending to the fires under the boilers, in sharpening tools, and doing other acts of manual labor, is not a person whose sole or principal duty is that of superintendence, within the meaning of the statute relating to fellow servants.

O'Neal v. O'Leary. (Supreme Judicial Ct. of Massachusetts.) 41 N. E. Rep. 662.

Rights of Lower Riparian Owner.—If a mine owner places the refuse from his own mine on his own land, in a position from which it is washed into a creek by ordinary storms, and damage thereby results to a lower owner, he is liable. Thus, where, in an action by a lower riparian owner to recover for damages by the overflowing of a stream which flowed through another's mining lands it appeared that the water used by the upper owner in washing the coal passed through a trough constructed by him to a point from which it was discharged on his own land but from that point it passed into the stream thickly charged with coal grit, depositing a fine coal dust in the bed of the stream until it was filled to its banks, when it overflowed over the land of the lower owner to a depth of several feet, completely destroying the land and also growing timber, the upper owner was liable for the damages.

Hindson v. Markle. (Supreme Ct. of Pennsylvania.) 33 At. Rep. 74.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any corrections in composition that may be required. Communications should not be too lengthy, and personal criticisms should be carefully avoided.
All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.
The Editor is not responsible for views expressed in this Department.
Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.
Questions on subjects not directly connected with mining will not be published.

A Fan Problem.

Editor Colliery Engineer and Metal Miner:

SIR:—I will be obliged if one of your readers will answer the following question for me, and before asking it I will take the liberty of explaining the conditions that have given rise to it. We had a fan 12 feet in diameter, which was run at 105 revolutions per minute, and produced a ventilation of 43,000 cubic feet of air per minute with .4 inch of water gauge. We have replaced the old fan with a new one, also 12 feet in diameter, and run at 105 revolutions per minute, but the water gauge is still .4, and yet the new fan gives an increased quantity of 60,000 cubic feet of air per minute, and this we think should have been done with an increased water gauge. I will therefore be glad to know what is the cause of the small gauge in the last question, for, I may say, the old fan was driven with an engine of 15 H. P., whereas the H. P. of the double engine for the new fan is 70. Yours truly,

JAMES HANN.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Will you kindly publish the following questions for answers in your valuable paper?

1. Two shafts 6 feet by 6 feet, each 1,000 feet deep, pass 45,000 cubic feet of air per minute. How much must they be enlarged to reduce the power required one-half?

2. In a certain mine there are 10,500 cubic feet of air per minute passing in an airway 5 feet by 6 feet and 2 miles long. Work was continued until the airway was 2½ miles in length, when a creep came on, which reduced the airway in area for 1 mile to 15 feet, or 5 by 3 feet, and for a further distance of one-half mile to an area of 10 feet, or 4 feet by 2½ feet. What quantity of air should then pass, the power remaining the same?

3. What action takes place when tobacco smoke comes into contact with marsh gas? I have seen a small quantity of marsh gas disappearing, or at least, I could not detect it with the safety lamp, after a small pipe of tobacco had been smoked in the place. No air current or other disturbance removed the gas.

Yours, etc.,

P. C.,

Dominion No. 1, C. B., Nova Scotia.

Jan. 6th, 1896.

To Find Any Root.

Editor Colliery Engineer and Metal Miner:

SIR:—I think the following method of extracting any root will be useful to many of your readers:

1. Let G be the number given and R the root to be found, and n the index.

2. Find by trial a number that is near the required root and represent it by r. Raise this number to the required power and represent this power by A. Then, as the sum of $n+1$ times A, and $n-1$ times G, is to the sum of $n+1$ times G, plus $n-1$ times A, so is r the trial root to R the true root.

For example, suppose in this case we require the fifth root of 9 or $\sqrt[5]{9}$.

By trial, we find 1.5 is too little, because raised to the fifth power it gives 7.59375, and 1.6 is too large because its fifth power is 10.4857; so we take 1.5 for r. Then, the correct root R can be found by compensation by the above rule, as follows:

$$[A\times(n+1)]+[G\times(n-1)]:[G\times(n+1)]+[A\times(n-1)]::r:R.$$

Substituting the values already obtained, we have

$$[7.59375\times(5+1)]+[9\times(5-1)]:[9\times(5+1)]+[7.59375\times(5-1)]::1.5:R,$$

or, reducing, 81.5625 : 84.375 :: 1.5 : 1.551724, the root required.

By the above formula any root can be found with near approximation.

Yours, etc.,

THOS. HANNAH,

Dunlo, Pa.

Pumping.

Editor Colliery Engineer and Metal Miner:

SIR:—I submit the following in reply to Assistant Superintendent, Nelsonville, Ohio, in the November issue of your valuable journal: "Will some correspondent please give a simple rule for determining the size of steam pump necessary to pump 30,000 gallons of water per day from a mine where the vertical lift is 100 yards. The steam pressure at the boilers on the surface averages 90 lbs. per sq. in. and the pipe which is covered with asbestos covering runs on the surface for 56 yds. then down the shaft 100 yds., and then 8 yds. to the pump? What size steam pipe and what size column pipe should be used? Also will a separator placed in the steam pipe near the pump permit of the use of a cheaper plant than if there is no separator?"

To compute the area of water cylinder or plunger,

$$\frac{N}{P\times G}\times 144 = A.\qquad \sqrt{\frac{A}{.7854}} = \text{diameter.}$$

N = Number of gallons to be pumped per minute. P = Piston speed in feet per minute. G = Gallons in a cubic foot. A = Area of cylinder in sq. in. In good practice the discharge pipe should not be less than .6 the diameter of the water cylinder or plunger, and the suction pipe should be ½ inch larger than the discharge for ordinary purposes. To determine the pressure in pounds necessary to overcome the friction of the discharge, Weisbach, gives us the following formula:

$$\left(.0144+\frac{.01746}{\sqrt{V}}\right)\times\frac{L}{D}\times\frac{V^2}{5.4} = H\times .434 = B = \text{pressure in lbs.}$$

H = Head in feet necessary to overcome the friction of the discharge pipe. L = Length of pipe in feet. D = Internal diameter of pipe in inches. V = Velocity of water in ft. per second. B = Pressure in lbs. necessary to overcome the friction of the discharge.

Having determined the value of B, or the pressure in lbs. necessary to overcome the friction of the discharge, the area of the steam cylinder can be computed in the following manner:

$$\frac{H\times P+B\times S}{E} = A.\qquad \sqrt{\frac{A}{.7854}} = \text{diameter.}$$

H = Height in ft. the water has to be pumped. P = Pressure per sq. in. due to vertical height of column which is equal to .434 lbs. for each foot in height. B = Pressure in lbs. due to friction of discharge. S = Sq. inches in water cylinder. E = Effective steam pressure which should be taken at ⅔ the boiler pressure. A = Area of cylinder in sq. inches. The diameter of the steam pipe should be .125 the diameter of the cylinder where the cylinder does not exceed 15″ in diameter, but where the cylinder exceeds 15″ in diameter the steam pipe should be .175 the diameter of the cylinder, and the exhaust pipe must be from ½″ to 1″ larger than the steam pipe. When computing the area of the respective cylinders, due allowance must be made for leakage, friction, etc.

For example, required the size steam pump necessary to deliver 30,000 gals. of water per day of 10 hours, from a mine 100 yds. deep. Boiler pressure 90 lbs. per sq. inch,

Ans. $\frac{30,000}{10\times 60}$ = 50 gals. per minute to be pumped; now make the piston speed 75 ft. per minute, then $\frac{50}{75\times 7.5}$ = .0888. Now if the pump gives an efficiency of 90 per cent., then $\frac{.0888\times 100}{90}$ = .0986 +,

.0986 × 144 = 14.1984 sq. in. area of water cylinder, $\frac{14.1984}{.7854}$ = 18.07, $\sqrt{18.07}$ = 4.25″ diameter, 4.25 × .6 = 2.55″ diameter of discharge pipe, 2.5 + .5 = 3″ diameter of suction. Now before we can determine the area of the steam cylinder, we must find the pressure in lbs. necessary to overcome the friction of the discharge, and in order to do this we must ascertain the velocity of discharge in ft. per second. Therefore, 2.5² : 4.25² :: 75 ft. : 216.75 ft., and $\frac{216.75}{60}$ = 3.61 + ft. per second velocity of discharge, and $\sqrt{3.61}$ = 1.9; then, $\frac{.01746}{1.9}$ = .00918 +, .00918 + .0144 = .02358, $\frac{160\times 3}{2.5}$ = 192 and 192 × .02358 = 4.52736, $\frac{3.61^2}{5.4} = \frac{13.0321}{5.4}$ = 2.413 +; 4.52736 × 2.413 = 10.92451968 feet, 10.9 × .434 = 4.73 + lbs., say 5 pounds. Now to find the area of the steam cylinder, $\frac{[(100\times 3\times .434)+5]\times 14.2}{60}$ = $\frac{2029.144}{60}$ = 50.48 sq. inches, and if the engine gives an efficiency of 75 %, then $\frac{50.48\times 100}{75}$ = 67.3 sq. in. area of steam cylinder, $\frac{67.3}{.7854}$ = 85.68, $\sqrt{85.68}$ = 9.25 in. diameter, 9.25 × .125 = 1.15625 in., say 1¼″ steam pipe, 1¼″ + ½″ = 1¾″ say a 2″ exhaust pipe. Therefore, a steam pump of the following dimensions will do the work required:

Water cylinder	4¼	inches in diameter
Discharge pipe	2½	" "
Suction pipe	3	" "
Steam cylinder	9¼	" "
Steam pipe	1¼	" "
Exhaust pipe	2	" "
Stroke	18	"

A separator is nothing more than a water trap, and will not permit of the use of a cheaper plant. But a good separator will add to the efficiency of the plant, furnish drier steam, and allow of better lubrication.

Yours, etc.,

YTNAC, Oskaloosa, Iowa.

Jan. 18th, 1896.

Air Compressors.

In this age of power transmission of compressed air, particularly in mining operations, any first class literature on air compressing machinery is of interest. The new catalogue of the Norwalk Iron Works Co., a copy of which is at hand, is a first-class text-book on compressed air and compressed air machinery, as well as a handsome catalogue. It is a well arranged and substantially bound volume of over 100 pages, and the matter contained in it will not only interest, but will prove of value to every mine manager and mining engineer. Copies are sent free, on application to The Norwalk Iron Works Co., South Norwalk, Conn.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for February.

QUES. 205.—As we are determined to leave no stone unturned until we secure all the necessary facts for constructing a new lamp on correct principles, will you tell us how much the illuminating power of the light of a safety lamp is reduced in its passage through the glass cylinder that surrounds it? Base your calculations on the following thicknesses: $\frac{3}{16}$ inch, ¼ inch, $\frac{5}{16}$ inch.

QUES. 206.—We are constructing boilers for raising steam by the burning of bituminous coal in the State of Tennessee, and as we are going to manufacture fine white paper we wish to consume all the volatile matter and soot given off by the burning coal; will you, therefore tell us how this objectionable matter could be consumed, and thus increase our available energy instead of wasting it by allowing this combustible matter to escape? We do not want any plans or sections for the construction of a furnace, as we can do them ourselves when you supply us with the principle required for the burning of this waste carbon.

QUES. 207.—Our bituminous coal is of excellent caking quality, but the demand for coke is small and the price is low; the vein is tender and we make 40 per cent. of slack. We have a good market for household coals and I have recommended the manager of the company to make the slack into briquettes, and he replied, if you can furnish me with a successful plan for doing so, I will advise the company to raise your wages $50 a month. This being so, I will be obliged to you if you will assist me by supplying the following facts:

First—Which of the following materials will make, from a physical point of view, the best binder for the briquettes: Clay, hydraulic lime, Portland cement, asphaltum, pitch?

Second—Which binder gives the best appearance to the briquettes?

Third—Which binder is the best for its price and commercial advantages?

Fourth—What are the best forms and dimensions to give the briquettes?

Fifth—How are the briquettes made, and where are any briquette presses with their mixing appliances to be seen in the United States.

QUES. 208.—Where is asphaltum mined on the continents of North or South America? What are the characteristics of its physical and geological environment; that is to say, is it found in veins or in solution in oils? Has it any connection with salt lakes? Was its origin vital or chemical? And further, to what general uses is it applied? And what is its chemical composition?

QUES. 209.—By closely watching four men at work, namely, a, b, c, and d, we found that a and b could fill 65 tons of coal in 5 days; a and c could fill 84 tons in 7 days; a and d could fill 44 tons in 4 days; b and c could fill 135 tons in 9 days; b and d could fill 42 tons in 3 days; and that c and d could fill 78 tons in 6 days. Will you tell us, then, how many tons of coal each of the men, that is, a, b, c or d, separately can fill in one day?

QUES. 210.—A shaft for a coal mine has been sunk to a depth of 1,000 feet, and at a depth of 898 feet we tapped a feeder of water that shed 500 gallons per minute, and after an accident to the engine that caused the stoppage of the pumps, the water rose to a height in the shaft of 700 feet. The sectional area of the shaft is equal to 140 square feet, and I will be obliged if you will make a diagram to scale, showing by the ordinates the velocities of the inflowing water at eight equally distant points in the elevation, and while you are busy, please calculate for me the time required for the feeder to fill the shaft to a height of 700 feet.

Answers to Questions which Appeared in the December Issue, and for which Prizes Have Been Awarded.

QUES. 193. As we are trying to make our new patent safety lamp the best in use, we cannot be over careful in avoiding the errors that may spring from our own ignorance. Now there were two of the primitive lamps that were furnished with glass chimneys, and one had it set within the gauze cylinder, as in the Stephenson lamp, and the other had the chimney set over and outside of the gauze, as in the Jack lamp, and to make the use or intention of these glass chimneys so clear that we may discover any essential principle in them that should be incorporated in the structure of the new lamp, will you please explain to me four things?

First. What was the use of these glass cylinders in promoting safety?

Second. Did these glass chimneys increase or diminish the light from the lamp?

Third. Did these glass cylinders increase the motive column and make the lamp burn where other lamps would go out?

Fourth. Was the safety of the lamp increased or decreased when by accident the glass cylinder was broken?

ANS. First. The object of the glass cylinder was to act as a shield or bonnet and prevent the possibility of swift currents of air and gas blowing the flame through the meshes of the gauze.

Second. The glass chimney could not allow the passage of more than 60 per cent. of the light, and this was still further considerably reduced by the wire lines of the gauze.

Third. The glass cylinders no doubt increase the motive column in pure air, while in foul air they reduce it.

Fourth. The safety of the lamp was decreased below that of the standard of a Davy lamp, because the diameter of the Stephenson gauze was at least ½ an inch larger than that of the Davy, and as a consequence its contents of flame were greater.

WILLIAM GILLIE,
Grindstone P. O., Pa.

Second Prize, CHARLES E. BOWRON, Tracy City, Tenn.

QUES. 194. Before commencing to sink we are boring to find the thickness of the seams, and those of the intervening and overlying strata, and the general direction and amount of the dip. We have two good seams, and the top one *A*, according to the prevailing thicknesses east of us, should be 4.5 feet, and that of *B*, the lower seam 3.75 feet, and in addition we know that the thickness of the rocks between *A* and *B* should be 104 feet; but if the excited story of our master borer is to be believed, these thicknesses will be found to be quite different for the following reasons:

At 2 o'clock this morning our house door-bell rang most violently, and running to the stairs I shouted, "Who's there," when a voice replied, "It is me, the master borer from Hardrock," and he continued, "I bring good news, we have cut seam *B* with the bore tubes at 57 feet instead of 104 feet," and I said "Good, that will save the expense of boring the other 47 feet," but he replied, "That is a trifling consideration, and this is what you should know. The thin intervening rock indicates a thick seam, and instead of 3.75 feet, the *B* seam will most likely be 6 feet." Now this is good hope if it is not good news, and I will be obliged if you will tell me on what geological facts or principles the master borer founded his opinion. I may say that all the mines east of us are deeper to the *A* seam than we are.

ANS. The master borer founded his opinion on the facts of his experience supported by the teachings of geology, for he knew that the decreased thickness of the rocks between the seams *A* and *B*, at the western side of the field, proved that the vegetable deposit that originated the seam *B* was submerged on its eastern side before it had completed its thickness on the west where our royalty is situated, and it is known to all observing miners that when the covering rocks of an underlying seam are thick, the coal vein is sure to be thin, and *vice versa*.

WM. R. PRICE,
Chandler, Colo.

Second Prize, WILLIAM GILLIE, Grindstone P. O., Pa.

QUES. 195. Will you calculate for us the quantity of air in cubic feet per minute we will obtain with a 2 inch water gauge. The fan is 30 feet in diameter and runs with an angular velocity of 90 revolutions per minute, the diameter of the central orifice of intake is 12 feet, the area of the throat of the fan is 130 square feet, the area of the orifice of discharge is 60 square feet and the radial length of the blades is 9 feet.

ANS. The diameter of gyration will be $30 - 9 = 21$ feet, and therefore the mean velocity of the radial column in feet per second will be $\frac{21 \times 3.1416 \times 90}{60} = 98.96 = v$. The weight per square foot of section of the radial column will be $.0766 \times 9 = .6894$ of a pound; and the pressure due to the velocity will be $\frac{98.96^2 \times .6894}{3.1416 \times 32.16} = 66.87$ pounds $= T$. Then $\sqrt{\frac{(66.87 - 10.4) \times 1,800,000}{(2130 + 10.4^2)}} = 213.11$ is equal to the velocity of the air in feet per second rushing out of the smallest orifice, that is in this case equal to 60 square feet, and if we take the *vena contracta* at .62, the quantity will be $213.11 \times .62 \times 60 \times 60 = 475,664.5$ cubic feet of air per minute.

CHAS. E. BOWRON, Tracy City, Tenn.

Second Prize, DAVID P. BROWN, Dunbar, Fayette Co., Pa.

QUES. 196. We are passing 86,400 cubic feet of air per minute through an airway 10 feet high, 12 feet wide and 3,000 yards long with a water gauge of 3.29 inches, and as we do not now require such a large quantity for this district, we are going to reduce the supply with a regulator and pass instead only 36,000 cubic feet per minute, and we will be obliged to you if you will calculate for us the area required in square feet to pass the stated quantity through the regulator. Make the coefficient for the *vena contracta* .65, and the co-efficient of friction .00000001.

ANS. The pressure required to overcome the friction of the airway will be $\frac{36000^2 \times 3.29}{86400^2} = .57118$ of an inch of water gauge, and the effective pressure at the regulator will be $3.29 - .57118 = 2.71882$ in inches, and in pounds $2.71882 \times 5.2 = 14.137864$. The velocity in feet per second will be $\sqrt{\frac{14.137864 \times 1,800,000}{2120}} = 108.335$, and the area at the regulator will be $\frac{36,000}{108.335 \times 60 \times .65} = 8.52$ square feet.

ADOLPHE COOK, Houtzdale, Pa.

Second Prize, ALFRED C. BLAKE,
East Peoria, Tazwell Co., Ill.

QUES. 197. We have sold a conical heap of coals to three persons *A*, *B* and *C*, and to prevent injustice of any kind, we will be obliged for your assistance in furnishing us with the heights at which each purchaser will have obtained his correct weight. For example, the cone is 42 feet high, and the diameter of the base is 90 feet, and as a cubic foot of these broken coals weighs 53 pounds, will you first tell us what is the total weight of the heap, in tons of 2,240 pounds, and as each of these persons have paid for one-third of the weight of heap, we have arranged to surround the heap at the height you give us with a platform, so that *A* can only cut off the top of the cone to get his share, and then we will erect the platform to allow *B* to obtain his share, and the remainder will be *C*'s share. Now please tell us how high the platform should be set for *A*'s share to cut off a cone, and for *B*'s to cut off a frustum, and leave *C* his just share as the remaining frustum.

ANS. When the angles of the apices of two or more cones are equal, then their contents are directly proportionate to the cubes of their heights, and if *h* is taken as the height, or 42 feet in this case, we will see that the elevation of the platform for *A* to get his share must be $h - \sqrt[3]{\frac{h^3}{3}} = 42 - \sqrt[3]{\frac{42^3}{3}} = 42 - 29.12 = 12.88$ feet, and the elevation for *B* to get his share must be $h - \sqrt[3]{\frac{2h^3}{3}} = 42 - \sqrt[3]{\frac{42^3 \times 2}{3}} = 42 - 36.69 = 5.31$ feet, and therefore the remaining frustum will rest on the ground.

The weight of the heap of coals is

$$\frac{90 \times 90 \times .7854 \times 42 \times 53}{2240 \times 3} = 2107.3 \text{ tons.}$$

JOHN A. RAY,
P. O. box 376. Westville, Picton Co., Nova Scotia.

Second Prize, JOHN BEATTIE, Danville, Ill.

QUES. 198. Why is anthracite coal broken in pieces before it is sent to the market for sale and for use as fuel?

ANS. The prime necessity for the breaking of anthracite coal is its property of slow burning when in large pieces, for then the surface under combustion is relatively small, and when broken into proportionately small pieces the surface exposed for combustion is vastly increased. Bituminous coal does not require breaking because when burning it swells, cakes and cracks, and thus by the operation of heat it increases its own surface for the action of the fire, and makes the necessary passages for the required supply of air, whereas anthracite coal only burns on its planes of fracture, and yields no pitch for binding it into cinder, and does not generate sufficient volatile matter to shatter it and make air channels through the mass.

WILLIAM HIBBS, Scio, O.

Second Prize, CHAS. E. BOWRON, Tracy City, Tenn.

The Action of Electric Currents on Mine-Surveying Instruments.

(By W. Lenz.)

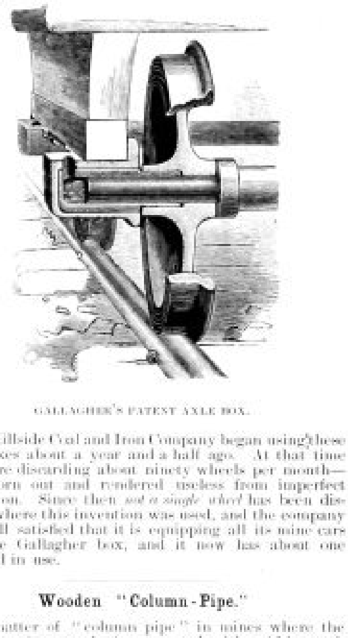
(Abstracted from *Glückauf* for the Institution of Civil Engineers, Great Britain.)

In view of the rapid increase in the number of electric railways in the Westphalian coal field and in the use of electric power under ground, the question of the action of electric currents on magnetic mine-surveying instruments is of such great interest that the author has been induced to conduct a series of experiments. A point, underground, was selected at a horizontal distance of some 100 yards from the rails of the Bochum-Herne electric railway, and 434 m (1,420 ft.) below it. There, by means of a Fennel's magnetometer with quartz fibre suspension, a series of observations of variation were made based on a fixed line. The magnetometer was previously compared for a long period with the apparatus in the Bochum Town Park, and the two instruments were found to coincide almost exactly. The first observation, in September, 1895, was made by day, the second by night, when the line was free from current, and the last again by day. Whilst the curve of the day results exhibited great irregularities, that of the night results was perfectly regular and in accord with the magnetic records. The irregularities in quite small intervals of time amounted from 2·7 minutes to 5·4 minutes. As at first it was thought that the deviations might be ascribed to the iron-free safety lamps employed, a third observation was made in the morning, the lighting being effected by a stearine candle. The results were exactly the same as on the first day. As the observations were made at a comparatively large distance from other workings, and as the shaft was 200 yards away, it is evident that magnetic observations can, under such conditions, be only satisfactorily conducted during the night in the absence of the magnetic current. Another source of error is the safety lamp. Composed of various metals, the lamp in a hot condition sets up thermo-electric currents which act on the magnetic needle. In order to obtain information on this point, the author placed six mine surveyors' safety lamps free from iron, one at a time, first in a cold condition then heated, at the pole of a sensitive magnetometer. Of the six lamps examined, two, when cold, had no action on the needle, whilst all acted on it when hot. The deviations observed amounted to from 30 seconds to 160 seconds. A new benzine lamp, that had not previously been used, caused a deviation of as much as five minutes. The deviation increased with the temperature of the lamp. A quite new aluminum safety lamp caused the same deviation when cold as when hot. From these results it follows that the mine surveyor, before making magnetic observations with delicate instruments, should carefully test his lamp. The influence of slight magnetic properties may be lessened by holding the light in the prolongation of the magnetic axis. With side lighting great care is necessary.

Mine Cars.

The Forest City Car and Manufacturing Company of Forest City, Pa., is a new manufacturing concern located in the northern part of the Northern Anthracite Coal Field. This company has recently completed new shops, equipped with the latest and most approved appliances for the manufacture of mine cars, mine car wheels, axles, etc., and the officers claim to produce first-class mine cars, wheels, etc., at very low prices.

As a specialty, this company manufactures the P. F. Gallagher patent axle box. This is a new, simple and inexpensive device for oiling mine cars, which has proven its merit in nearly two years' practical service. It does not waste oil, and cannot get out of order.



GALLAGHER'S PATENT AXLE BOX.

The Hillside Coal and Iron Company began using these axle boxes about a year and a half ago. At that time they were discarding about ninety wheels per month—hubs worn out and rendered useless from imperfect lubrication. Since then *not a single wheel* has been discarded where this invention was used, and the company is so well satisfied that it is equipping all its mine cars with the Gallagher box, and it now has about one thousand in use.

Wooden "Column-Pipe."

The matter of "column pipe" in mines where the mine water is strongly impregnated with acid is a serious one to many mine managers. To meet such conditions, Ayrault Bros & Co., Tonawanda, N. Y., (whose advertisement appears elsewhere in this issue) manufacture the coated wooden pipe shown in the accompanying

WOODEN "COLUMN-PIPE."

illustration. The construction of this pipe is so clearly shown in the engraving as not to need any detailed description. This pipe is made of various degrees of strength (according to the metal banding used) up to that sufficient to work under 240 feet head, which will cover most cases of mining service. It will pay mine managers who have serious cases of pipe corrosion on hand to communicate with the makers of this pipe.

A Good Rope Record.

The crucible steel cable tramway rope supplied by Messrs. George Cradock & Co., of Wakefield, for the Brixton Hill line of the London Tramways Company, in 1893, was removed in November last, after having been at work for 853 days at a speed of 8 miles per hour. The total rope-miles were 123,120, and the car-miles 1,791,233. The rope in question was Lang's lay. It was 30,000 ft. long and 3½ in. in circumference when new, and ¼ in. less when removed. The cost of the rope per car-mile was .1698 *d*.—*Engineering*, London.

Messrs. Cradock & Co. furnish their make of ropes to American users through Mr. T. A. Wigham, 513 First National Bank Building, Chicago, Ill.

REMOVAL.

The New York office of the Rand Drill Co. has been removed from No. 23 Park Place to the American Surety Building, No. 100 Broadway.

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AND

METAL MINER.

WITH WHICH IS COMBINED THE MINING HERALD.

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All communications should be addressed,

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WEAR ON HAULAGE ROPES.

EVERY mine manager knows that the most destructive agency in the wearing of haulage ropes is the sawing of the rope over pulleys which fail to revolve, or over pulleys that are worn unequally and fail to revolve as quickly as they should. The latter class of pulleys sometimes remain stationary with their thicker and heavier sides down, until they are cut through by the constant friction of the passing rope. This naturally wears the rope rapidly, and the friction increases the pull or strain on it.

A roller has been extensively adopted at British mines that seems to have largely remedied this fault. This roller is corrugated or grooved along its entire length, and practice has shown that each groove in the rope gets a fairly equal amount of usage, according to the limit of curvature of the track. The roller is made of rolled and stamped wrought iron or steel, well balanced and true. They can be made of equal thickness, a quality which cannot always be acquired in a cast iron roller. These rollers are said to revolve almost at the instant that they are touched by the moving rope, and they acquire a greater grip or hold than the flat surface rollers, owing to the clinging form of the grooves. Every man who has had any experience with rope haulage has frequently noticed the tendency of the rope to run in the groove worn on an original flat surface roller, or to slide to the flange of a new flat surface roller. This tendency is taken advantage of in the rollers constructed with grooves or corrugations, and excellent results in greater life for ropes are reported. The idea seems to be a rational one and is worthy a trial.

A DENVER OFFICE.

WE have opened an office for THE COLLIERY ENGINEER AND METAL MINER, in Room 502, Boston Building, Denver, Colo. It is in charge of Prof. Arthur Lakes, assistant editor. Subscriptions, etc., will be received at that office, as well as at the main offices in Scranton.

AN ENGINEERS' CLUB IN CHICAGO.

THE tendency for men of one profession, or of allied professions to meet together socially has resulted in a number of instances in the formation of technical clubs.

These clubs are practically first class European plan hotels and restaurants, the accommodations of which are limited to members, or to friends of members. As a rule, they are equipped with libraries and reading rooms that appeal to the tastes of the men composing the club.

There is a movement on foot to establish such a club, to include in its membership members of the various engineering professions only, in the city of Chicago. The indications are that the club will be a success. It will consist of resident and non-resident members. The initiation fee and dues have been fixed at very moderate figures. The gentlemen connected with the organization of the club have received acceptances from nearly enough engineers who will enroll as members to warrant us in saying that success seems assured. It is a good movement, and deserves the support of every engineer residing in Chicago, or who is a frequent visitor to that city.

CARBON MONOXIDE AS AN EXPLOSIVE AGENT.

A THEORY advanced by Prof. Lewes, of London, if correct, furnishes an explanation as to the cause of many mysterious mine explosions. The poisonous effect of carbon monoxide or "white damp" has been recognized by miners for years, but its explosive characteristic has not been commented on because it was universally supposed that its poisonous effect was made apparent before a sufficient quantity of the gas to make, with the air, an explosive mixture could accumulate.

In commenting on ordinary black powder as an unsuitable explosive in gaseous or dusty mines, Prof. Lewes calls attention to the fact that carbon monoxide is the one resulting constituent of its explosion. It has been conclusively proved that when fire-damp is present in such minute quantities as to form a mixture very far removed from the point of explosion, under ordinary circumstances, it does form, when coal dust floats in the air, a highly explosive mixture. He states that traces of carbon monoxide will do exactly the same thing when the air is laden with coal dust. Besides, the temperature necessary to ignite a mixture of carbon monoxide and dust laden air is lower than that required to ignite a mixture of fire-damp and dust laden air. Prof. Lewes, therefore, concludes that when the air of a mine is charged with coal dust the probabilities are that a very large volume of explosive mixture is formed by the rapid escape of the products of combustion into the dust laden air, and this (being ignited either by the flame or by red-hot solid products driven out into it by a blown-out shot) initiates a considerable area of explosion.

FREE MINING LECTURES.

THE Department of Mining of the Pennsylvania State College, offers to deliver a series of free lectures to mine employes, *at their customary places of assembly*, on the following subjects: The Care of Explosives, The Danger of Safety Lamps, The Cause of Mine Explosions, Propping and Pack Walls, and Wasting Energy at Labor.

These are all interesting and important subjects, and the opportunity given to Pennsylvania miners to hear instructive lectures from competent men should be taken advantage of generally. All that is necessary to secure this advantageous offer is for the miners of each locality to secure a suitable room and arrange for an audience, the State College will furnish the lecturer.

FAILURE IN MINING.

THE very common cause of failure in mining is lack of good mine management. Very often the mine itself is blamed, and wrongfully blamed. As an evidence that successful mines are not always those that produce the highest grade ores we quote the following from the report of the Director of the Geological Survey of the United States:

"In the history of the California mines, a number of claims, like the Cederberg, Chariot, and others, which yielded very rich gold specimens, such as are worked into jewelry and souvenirs, have been very disappointing; while on the other hand, the ore of many of the famous and most productive mines, hardly ever contains gold sufficiently coarse to be seen by the naked eye. The vast low grade auriferous deposits of Dakota, which have been so remunerative, had an average yield in 1880 of only $6.33 per ton. Very many large mines, both in California and Dakota, have been worked at a good profit on ore which carried much less gold."

Commenting on "Waste in Mining" our contemporary, *The Australian Mining Standard*, pointedly states this frequent cause of failure in the following statement:

"Bad management takes such a multitude of shapes that it is almost impossible to describe it, unless it be described in the general term 'ignorance of mining.' Its most common form is seen in the wastage of ore. A general proof of the fact is found in the hundreds of dumps which have been hand-sorted over and over at a profit. There is an old saying that 'a good workman can be known by his chips,' and with equal truth it can be said that 'a bad mine manager can be known by his dumps.' One thing that is indispensable in a manager is an appreciation of the necessity of thoroughly understanding the nature and value of his ore. He may not be able to understand that ore himself, but if he appreciates its importance, he can employ someone who does understand it to take charge of necessary work.

"The world sees the evidence of waste in the dumps that lie in the daylight, but there is a still greater source of waste that is hidden from the public in the dark stopes of the mine. Every practical man knows how often the ore is knocked down in the stopes, and there partially sorted, and the supposed waste left upon the stulls. If ore sorted by daylight loses much of its value in the waste, what is the loss liable to be in the dark, narrow and cramped stopes? Who that is competent to hand-sort ore gives, in the great majority of instances, any attention to this portion of the work? As a rule the miner is allowed to have his own sweet will in this labor, and his own sweet will is too often to do that which is easiest, instead of that which is best, even if he knows what is best.

"This is but one kind of waste, and the commonest one of bad management, where scores might be mentioned. To the man who understands it, the lack of assayers and assay offices, at individual mines, often suggests a doubt about the quality of the management. It is not all mines that require the constant services of an assayer, but a good many more than receive them do require them, and would find them the most valuable of all possible investments."

A Suggestion to Advertisers.

A well known concern manufacturing mine equipment begins, in this issue, a series of advertisements which will, in time, form a fair illustrated catalogue of their manufactures rather than a repetition of an illustrated business card with which most advertisers content themselves.

This innovation, though it involves more work and expense on the part of the publishers, we welcome. We would be glad to see the plan followed by all of our advertisers whose manufactures are such as to make it possible. Buyers, at the mines, like other men, buy those goods with which they are most familiar, other things being equal. There is no way in which makers of the various lines of mining goods can easier familiarize prospective customers with their manufactures than through advertising in THE COLLIERY ENGINEER AND METAL MINER.

If instead of, or at least supplementary to, the claims as to the merits of the goods, there appears in the advertisement a clear illustration of some machine or appliance made by the advertiser with a concise note appended stating the size, capacity, where in use in mining service, working conditions, etc., we feel safe in assuring our patrons of more careful attention to their advertisements than they could otherwise obtain. We know from expressions we have had from advertisers and subscribers that in few trade journals are advertisements as closely scanned as are those in each issue of this journal, but that is no reason for allowing advertisements to "run themselves."

It is worth while to spend time and money in the preparation of advertising matter in a paper which really brings returns, while it is a waste of both time and money to put good advertisements in poor papers. There is no reason why the advertiser should not give the same careful attention to the preparation and placing of his advertising matter that he does to other items of expense, such as traveling salesmens' salaries, or the preparation of catalogues.

To express the matter in the tersest manner, we would simply say a good advertising medium can be made a better one, if the advertiser will give the preparation of his advertisement careful thought.

Book Review.

COKE. A Treatise on the Manufacture of Coke and the Saving of By-Products. — *With special references to the Methods and Ovens Best Adapted to the Production of Good Coke from the Various American Coals.* By John Fulton, E. M., Member Am. Inst. Min. Engrs., Am. Philosoph. Soc., etc., etc. Large 8vo. 342 pages. Profusely illustrated. Cloth. Published by The Colliery Engineer Co., Scranton, Pa. Price, postpaid to any part of the world, $4.00.

The manufacture of coke in the United States began in a feeble way, with four small establishments, in the year 1850.

During the thirty years following, its progress was rather slow, but from 1880 to 1892 it made rapid advances, showing in the latter year 261 establishments, using 42,002 coke ovens and producing 12,010,829 tons of coke, valued at $23,536,141 at the ovens.

In the year 1869 the use of coke in blast furnaces outranked that of charcoal, and in 1875 surpassed anthracite coal.

Since the latter date it may be said that we have fully entered into the era of coke.

It is also evident that this coke fuel is destined to retain this leading place of usefulness in metallurgical operations, and its increase is destined to accompany the expansion of the iron and steel industries.

In considering the present condition and future requirements of the coke-making industry, with its paramount value in the manufacture of iron and steel, it appeared that a volume embracing the principles and practice of the manufacture of coke would prove of permanent value to those engaged in these co-related industries.

Its publication is regarded as the more needful at this time, on account of the efforts being made to introduce the modern types of retort coke ovens, with their auxilliary apparatus for saving the chief by-products, of tar and sulphate of ammonia, from the gases expelled in coking, and thus supplement the profits in the coke industry.

In the United States, the manufacture of coke has hitherto been confined mainly to localities affording the best qualities of coking coals.

It required little skill to make excellent coke from such good coals. But with the large expansion of the production of coke, and the gradual exhaustion of the areas of the prime coking coals, compelling the use of the secondary qualities of coking coals, a thorough study of the merits of the several kinds of coke ovens now being offered, is regarded of the most important interest.

In this volume, the papers on the manufacture of coke, which have been published in The Colliery Engineer and Metal Miner, have been recast and carefully revised. They exhibit the several methods of coking, with accurate results, for the consideration of those interested in this industry.

The author feels that very much remains to be learned in this department of industrial art; but trusts that this initial volume will suggest matter that will lead to an accelerated advance in useful knowledge along the several sections embraced in its pages.

The work has been undertaken with a feeling of the difficulty of doing it the justice its importance deserves, but in this respect the author trusts that some truth has been gleaned under the conditions of the old adage that "necessity is the parent of invention."

In the twenty years' experience of the author, in his official position of general mining engineer and general manager of the Cambria Iron Company, he has been required to study the manufacture of coke in its elements of quality and cost. The extensive operations of this company in the different sections of the Appalachian coal region, by several methods of coking, afforded desirable opportunities for investigation and for the comparison of results.

In the year 1875, the coke made at the works at Johnstown, in Belgian coke ovens, failed to meet the furnace requirements. The management requested an investigation of the cause or causes of the inefficiency of this fuel in blast furnace work.

It appeared at first an easy task to ascertain the nature of the defect or defects in this coke. It was assumed that a chemical analysis would disclose the whole matter; but, contrary to expectation, it did not; it showed the coke to be very pure, with much less ash than the Connellsville, and with marked exemptness from other injurious elements. The result compelled an expansion of the method of investigation, as the chemical method alone would not reveal the cause.

A study to devise a method for the physical examination of the coke was then entered upon, which, after many trials, resulted in developing a plan that disclosed the main cause of the failure of this coke for blast furnace use—its want of the principal requirement, "hardness of body."

From the softness of the body of this coke, much of it was wasted in the upper section of the blast furnace, by dissolution in the bath of the ascending carbon dioxide gas, thus lowering the temperature at the zone of fusion, and disarranging the regular operations of the workings of the furnace.

These early methods of testing the physical properties of coke were very crude and open to criticism, but the urgency of necessity, it is believed, has ultimately disclosed accurate methods of determining the true value of coke for metallurgical uses, the practical results in furnace work sustaining the reliability of these determinations.

It has become evident in the manufacture of coke from the secondary qualities of coking coals, that from the nature of the requirements of quick and high oven heat to secure the hardest bodied coke possible from such coal, the retort type of coke ovens will have to be used. It is confidently hoped that the plans and statements of the actual work of these retort ovens, with and without apparatus for the saving of by-products, will prove helpful in enabling the coke manufacturer to make intelligent selection and application of the special type of oven best adapted to assure the best coke from the coal used in its manufacture. Very much care has been given to the consideration of the best modern methods in the preparation of coals for coking, especially in the processes of crushing and washing, with the elimination of slates and pyrites.

The work is divided into nine chapters and an appendix. Chapter I. is devoted to the coal fields of the United States, their geographical position, extent, analysis, etc., etc. Chapter II. is devoted to the physical and chemical properties of coal, and the subjects are carefully, intelligently and exhaustively handled. Chapter III. is devoted to the preparation of coals for the manufacture of coke, and describes and illustrates all the latest and most approved apparatus for crushing, sizing and washing. Chapter IV. is devoted to coking in the open air, or in partially closed ovens of the beehive type. Chapter V. is devoted to the consideration of the various retort and by-product saving ovens. All types are described and illustrated, their merits and demerits discussed, and their successful application to various coals is treated on. Chapter VI. treats on the physical properties of the three principal fuels used in metallurgical operations, viz: charcoal, anthracite coal and coke. Chapter VII. is devoted to the consideration of laboratory methods of determining the relative calorific values of metallurgical fuels. Chapter VIII. is a consideration of the location of coke plants in the most convenient and economical manner. Chapter IX. consists of general conclusions on the work, cost and products of the several types of coke ovens. The appendix contains several consular reports on various systems of coking, tables of comparative tests, descriptions of new devices obtained too late for insertion in the body of the book, etc., etc., together with an official report of extended tests recently made in coking with Semet-Solvay ovens by Mr. Fulton for the Johnson Iron Co., and published by special permission of A. J. Moxham, Esq., President.

Throughout the work Mr. Fulton has realized that he was writing for practical men, and as a result, the volume is the only complete work on the subject ever issued. It is up to date in every particular, and is written in an exceedingly plain, concise manner.

MANUAL OF LITHOLOGY: Treating of the Principles of the Science, *with Special Reference to Megascopic Analysis.* Second Edition; by Edward H. Williams, Jr., E. M., F. G. S. A., Prof. of Mining Engineering and Geology, Lehigh University. 8 vo. Cloth. 418 Pages, illustrated by six full page plates. Price $3.00. Published by John Wiley & Sons, New York, and Chapman & Hall, Ltd., London. Prof. Williams' preface to this edition explains the nature and scope of the work so plainly and concisely that we give it almost in its entirety. "The microscope has forced lithology and petrography so widely apart that the layman is often at a loss to recognize old acquaintances under new names. This edition of lithology is written on the same basis as the last—for the beginner in the subject who wishes a thorough knowledge of the megascopic presentation of the subject, in a fuller and more compact arrangement than can be obtained in geological text books. It is also designed for the engineer who wishes to understand the valuation of rocks for economic purposes. The arrangement is such that those who wish to continue the work in the microscopic analysis of rock-forming minerals, as taught in petrography, will have nothing to unlearn. The reader is supposed to have a practical acquaintance with megascopic crystallography and mineralogy, the use of the blow-pipe, and the ordinary methods of chemical analysis, so that these subjects are merely touched upon in the description of the more common megascopic rock-forming minerals. An addition has been made in the line of the economic value of rocks, and the body of the book has been entirely rewritten, and is from five to six times the size of the former edition, so rapidly has the subject grown." Prof. Williams is one of the most practical and learned technical instructors in America, and in preparing this work he has carried out his usual plan of treating the subject in the most practical manner. As he states, by inference, the book is not specially written for men of very limited education, but rather as a text book and book of reference for mineralogical and geological students who have attained a certain standard of education. At the same time, each subject is so presented as to make it a useful book for men of comparatively limited education. It is arranged, and each subject classified in a very convenient and intelligible manner.

The Use of Metal Railroad Ties, and Preservative Processes and Metal Tie-Plates for Wooden Ties. By E. E. Russell Tratman, A. M., Am. Soc. C. E.; prepared under the direction of B. E. Fernow, Chief of Division of Forestry, and issued as a report by the U. S. Dept. of Agriculture. This is a very exhaustive and complete report on inventions, methods and appliances produced both in this country and Europe, by means of which the consumption of timber for railroad ties may be materially reduced either by the substitution of metal ties, or by appliances and treatments to wooden ties to prolong their life. The work is an exceedingly valuable one, as its object is to assist in preventing the rapid destruction of American forests. It shows that since 1890 the substitution of metal for wood in railroad ties has progressed steadily, until now more than 35,000 miles, or about 20% of the railroad mileage of the world, outside of the United States and Canada, is laid on metal. Although progress in this direction in America has been slow, it will be a question of but a short time till the waning of forest supplies will force on railroad companies the use of metal ties, and these, it is claimed, will insure greater efficiency, safety and final economy. In the meanwhile, preservative processes, such as creosoting, etc., and metal tie-plates may be applied to wooden ties with advantage, and this will no doubt help postpone the time when the metal tie, more expensive in first cost, will be adopted.

Personals.

Mr. Edgar G. Tuttle, mining and civil engineer, has opened an office at 221 Pearl street, New York City.

Mr. James G. Bateman, formerly inside foreman of the Albright Colliery of the Albright Coal Co., of Silverton, Pa., has been promoted to the superintendency of that company, succeeding Mr. James Archbald, jr., who becomes acting president.

Mr. Bateman was one of the first mine foreman to fight an extensive mine fire by the *direct* system successfully. An account of this fire appeared in the report of the state mine inspector for 1885, as well as in The Colliery Engineer (Mining Herald).

Following the promotion of Mr. Bateman, Mr. Charles F. Long becomes inside foreman and Mr. Charles J. Price, at present fire-boss, assumes the duties of night foreman.

Messrs. Long and Price are both students in the Correspondence School of Mines. All four are and have been for years, readers of The Colliery Engineer and Metal Miner.

Mr. A. W. K. Pierce, electrical engineer, resigned his position with The Correspondence School of Electricity, of the International Correspondence Schools, to accept a responsible position as an electrical engineer in the South African mining fields.

Mr. James P. Dickson has resigned as President of the Dickson Mfg. Co. of Scranton, after an incumbency of the office for nearly twelve years. Mr. Dickson has been succeeded by Mr. Charles H. Zehnder, who for the past three years was president of the Jackson & Woodin Co. of Berwick, Pa.

Mr. Thomas F. Downing of St. Clair, Pa., formerly assistant inside foreman at the Beechwood Colliery of the Philadelphia and Reading Coal and Iron Co., has been promoted to the position of inside foreman and will have charge of the Glendower and Taylorsville Collieries of the same company.

Mr. Downing has been a hard student and by merit alone has risen to his present responsible position. As a candidate for state mine inspector in 1894, Mr. Downing passed an excellent examination and demonstrated his ability both in the theory and practice of coal mining.

Messrs. George Mair and F. C. Whitmore, in charge of the General Electric Co.'s branch office in Scranton, have closed the Scranton office. Mr. Mair resigned his position with the General Electric Co., to accept a lucrative appointment in South Africa, and Mr. Whitmore, who continues with the General Electric Co., will make his headquarters at the Phila. office, No. 509 Arch street.

The Board of Examiners to examine candidates for State Coal Mine Inspectors for the State of Washington, completed its labors on the 16th ult. Messrs. David Edmunds of District No. 1, and Joseph James of District No. 2, were recommended for reappointment. Messrs. Edmunds and James have been readers of The Colliery Engineer and Metal Miner for years, and Mr. James is a student in The Correspondence School of Mines. His record as a student shows him to be a close student and a man of ability. He is well advanced in the course, in fact has almost completed it.

Messrs. Frank G. Clemens and H. W. Althouse have opened offices as mining engineers at Pottsville, Pa. Both gentlemen have had a number of years experience as engineers for prominent mining companies, Mr. Clemens having been for many years connected with the Lehigh Valley Coal Co. as an engineer, and lately with the Midvalley Coal Co., as superintendent of their extensive operations. Mr. Althouse was connected with the engineering department of the Phila. & Reading Coal and Iron Co. for several years, and later with the Consolidated Coal Co. of St. Louis, and other western and southern coal companies.

Mining Machinery.

To many of our readers, the name of Mr. Robert Allison as a builder of mining machinery is very familiar. After having to a large extent withdrawn from the business of manufacturing mining machinery for several years he has again assumed the direct management of his Franklin Iron Works, and in an advertisement in this issue solicits business in the line of hoisting and haulage engines, air compressors, pumps and mining machinery generally.

Mr. Allison's well known ability as a mechanical engineer and inventor, and the reputation of the work turned out at his shops in the past, guarantees that his customers will get machinery fully up the highest standard. He reports orders for a pair of 24″x60″ first motion hoisting engines 8 ft. drums, from the South, two pairs of large duplex air compressors from the Connellsville region, a lot of hydraulic cylinders for elevators, and sufficient smaller orders to keep his shops running full time. A new catalogue, which he has just issued, will be sent free to any mine owner or mine manager.

THE PROGRESS IN MINING.

Abstracts From the Proceedings of the Mining Societies

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

WESTERN PENNSYLVANIA CENTRAL MINING INSTITUTE.—A meeting of the members of this Institute was held at Pittsburgh, Pa., on Thursday, December 26, 1895, under the Presidency of Mr. T. K. Adams, Mine Inspector, and after the Secretary, Mr. Seddon, had read the minutes of the last meeting, and they were approved, the President then read his annual address.

He began by making an apology for intruding with a sharply defined question of duty instead of with an interesting novelty, and drew attention to the by-laws and aim and object of the Institute "and the dangers that menace it, and our duty as members thereto." "We are solicitous that nothing shall occur to mar the prosperity of the Institute, impede its progress, destroy its usefulness, or threaten its unity, peace and harmony.

After advising the members not to allow the intrusion in their meetings of matters foreign to their interests and the aims of the Institute, he drew attention to the provisions of the by-laws such as:

"The object of this Institute shall be the mutual improvement of its members in the science of chemistry, geology, steam, hydraulics, hydrostatics, mechanics, mine surveying, and other branches of science directly or indirectly connected with mining," and further "To aid and advocate in legislative bodies such laws as will be beneficial to the practice of mining, and to advocate the repeal of all laws detrimental to the interests of mining and the health and safety of the miners." Again, "Or such other matters as shall be agreed upon, but all such matters shall be in relation to the sciences directly connected with mines and mining." The President then proceeds to draw attention to the fact that their time has been wasted by cunning advertisers who strive to monopolize the attention of the members at the meetings with their wares and schemes, to the exclusion of such subjects as are sanctioned by the by-laws for investigation, and he says: "See to it, therefore, that these grand aims and and objects of our association are not perverted by allowing it to become the advertising and endorsing agency for the wares and schemes of selfish men."

This last paragraph furnishes the key-note of the President's address, and it is no doubt true that this institution in common with others in this and other coal regions of the world, is subject to these incursions of traders who damage their own cause by trying to force their wares on unwilling patrons and buyers. Altogether the speech is that of a brave, earnest and worthy president.

Mr. T. B. De Armit, in moving a vote of thanks to the President for his able address, endorsed the carrying out of the by-laws of the Institute, and he was supported by Inspector Jenkins, who thought the address and remarks were timely, and the vote being put to the meeting by Mr. T. B. De Armit it was unanimously received.

The President then called on Mr. Callaghan for his paper on stoppings.

* * *

STOPPINGS.—By Mr. Bernard Callaghan, Connellsville, Pa. Mr. Callaghan's paper treats on a very important subject, and aims at directing attention to a matter of prime importance, affecting as it may do the safety of life, and the prevention of great destruction of property. The writer begins by referring to the provisions of the mine law for the construction of the main stoppings in a mine; that is, they shall be built of suitable materials and be satisfactory to the mine inspector.

The general interpretation of this law is practised by building brick or stone stoppings, with the joints made close with mortar, so that they are strong enough to resist all normal pressures, and tight enough to prevent leakage.

Mr. Callaghan, however, points out that in the event of an explosion these solid stoppings would be all broached and destroyed, but being so strong, the force of the blast would extend to the shafts and do incalculable mischief, while on its journey there, it would draw out the timbers and break up the roof; and he points out what many practical men know, that when these brick stoppings are destroyed, current ventilation is impossible, and consequently the rescue of those living in the interior of the mine is prevented by the after-damp. He proposes the general use of hanging-door stoppings to act as relief valves, and therefore they will open by the pressure generated by the explosion, and so relieve the compression by diffusion, that comparatively little damage will be done, and the ventilation will be at once restored and the after-damp carried off with the normal return current. Mr. Callaghan's views are not only good, but we may say they are in actual use partially in England, for by act of parliament it is provided that relief doors or valves shall be placed over the outlet of every upcast shaft that is connected with a fan drift, to open and give relief to save the fan in the event of an explosion, and close after the force of the blast has expended itself. Again, T. E. Hall, Esq., superintendent of the Haswell and Ryhope collieries, England, is the holder of a patent right for the construction of doors in the floors of crossings, to lift and turn on hinges, and thus give relief to the blast of an explosion, and fall and close to restore the ventilation after the force of the explosion is over. But the act of parliament and the patent for crossing doors are only the same in character, but not the same in kind, as Mr. Callaghan's stoppings, and as he takes the wider view of providing a more copious relief, he deserves at any rate more than a passing notice, first, for his valuable practical paper, and second, for introducing to the notice of mine engineers the valve stoppings put in use by Mr. James Jackson in the Valley mine. The construction and mode of action of these door stoppings is as follows: The door is hung like the end gate of a mine car, and leans against a frame securely fixed, and the door is made air tight at the closure with canvass sheeting, so that these stoppings are practically as good in preventing leakage as the stone or brick ones. We hope no explosions will occur to test the automatic action of these door valves, but they are a provision that deserves the highest commendation, and are well worthy of being put to a practical test by an experimental explosion in an extemporized drift.

After the reading of Mr. Callaghan's paper, Mr. Stinner said that he hardly believed that door stoppings could withstand the force of an explosion, and he would rather make the rock stoppings stronger. Mr. Clifford, M. E., of Pittsburg, said that in cases of explosions it was always found that the most disastrous results occurred where the stoppings were not moved and the blast was confined, and he believed that door stoppings could be made to open and not be destroyed. Messrs. Connor and Hall then took sides with Mr. Stinner, and Messrs. Rigby and Britt took sides with Messrs. Callaghan and Clifford. After the reading of a report by a committee appointed to make some tests with ventilating fans, a paper on endless rope haulage was read and discussed, and then the president *pro tem.* called on Mr. Blick to open a discussion on the prevailing system of working the Pittsburg seam, but as he pleaded that his views were well known, the president then called on Mr. Hartley, who in a few well selected words went straight to the weak point, and showed that the present system of working was wasteful and required to be remedied, and he was supported by other speakers.

The following paper was prepared to be read at the meeting:

* * *

THE USE OF ELECTRIC MACHINERY IN COAL MINING.—By Mr. L. L. Brande. This paper is highly characteristic of the innovations of the time we live in, and the claims of the writer strongly emphasize the use of electric appliances in all the operations in mines where power is applied to do work. He claims that transmitted electrical energy secures greater efficiency and economy and thereby considerably enhances the profits of the mine operators.

The strong points in the paper may be summarized as follows:

First—Seeing that the loss by transmission of the current is so small, it may be neglected in the gross result, and therefore the power may be applied through a motor directly at the points where it is wanted, and that may be for pumping, drilling, coal cutting, and hauling, in the most distant nooks of the mine.

Second—As electrical transmission has advanced beyond the speculative and experimental period, its reliability and relative efficiency and economy is now undoubted, and stands within the compass of numerical values that can be calculated with certainty.

Third—As the principles of action of electric plants are now so well understood, the generators, cables and motors are constructed to secure durability with few repairs.

Fourth—Only one prime source of power is required to generate the current for lighting and for the multifarious motors that are located just where the work is required to be done.

Fifth—For undercutting coal the electric cutter does the work in one-half the time, and effects a saving of from 10 to 12 cents a ton.

Sixth—Mr. Brande gives his experience of eight months at the Nos. 2 and 3 mines of the Essen Coal Co., Hazletine, Pa., and the plant at these mines consists entirely of "Independent" electric machinery. The prime steam power is equal to 200 H. P. and these engines are used to drive three 150 kilowatt generators. There is always one engine and one generator kept in reserve. The three generators have had nothing done to them since last May save cleaning the commutator occasionally, and the oil in the bearings has been changed only once.

Seventh—Two electric locomotives are used for haulage, and each of them is capable of hauling 1,000 tons per day. They are giving excellent satisfaction. On a nearly level track the longest train hauled in No. 3 mine was 64 bank cars, each carrying from 25 to 30 cwt. In No. 2 mine the longest train was 38 bank cars, the grade varying from 1% to 2%. The lengths of the hauls were 3,600 and 4,200 feet.

Eighth—All the important partings and tipples of these mines are furnished with the electric light, and each motor has a headlight.

In conclusion, Mr. Brande predicts: "That the time will soon come when the price of coal will be based on the output of machine mines," and then operators will find their interests best served by using, wherever and whenever they can, these labor and time saving and profit-making appliances.

* * *

COLLIERY EXPLOSIONS PRODUCED BY COAL DUST.—The following is taken from the *Colliery Guardian*: Mr. Stuart's argument, that every colliery explosion in which coal dust plays a part is made up of a multitudinous number of distillations and explosions, will best serve the purpose of illustration if we quote the Udston explosion, which is one of the explosions referred to by Mr. Stuart in his last book. Certainly no other explosion of which we have the fullest details exhibits such strong evidence of instantaneous action, and personally I have always quoted the indications of this accident as more nearly approaching those afforded by detonation than of any other form of explosion with which we are acquainted. A few days since Mr. Dickinson (late her Majesty's inspector of mines), and who specially reported on this disaster, when writing to me in reference to the effects of sudden compression of the ventilating air-current in mines, called my attention to what he then reported on this subject. "The evidence showed that the main roads were the most dusty part of the mine, and not the rooms. It was, however, in the rooms not cut through and least dusty that there were the greatest signs of coking, extending not quite up to the face, and not in the main roads, some of the principal coking being in the rooms which were not at work.

"As regards the air being impregnated with fire damp, and an explosion being spread over a wide area by pressure, we (Messrs. Dickinson and Maconochie) would refer to a paper read before the Manchester Geological Society by Dr. Angus Smith, late chief inspector of alkali works, in which he described an apparatus (which he also exhibited to the society), by which he then thought that the mixture of small quantities of fire damp in atmospheric air might be detected by percussion. Soon afterwards, however, an improved instrument of the same nature, made by Mr. Dancer, optician, proved that the same result could be arrived at by the pressure of ordinary air without gas, on the principle of lighting tinder by percussion. This would afford a more likely solution of the widespread nature of the present explosion, with the force coming towards the shafts from different extremities, than that afforded by the supposition that it was the dust alone that carried the flame throughout the workings, especially in the dook, which it would have to enter quietly first, and then return, leaving the indications of the force outwards. The pressure of air, both in the dook and Blantyre sections, had been so strong as to draw every shred of clothing off some of the bodies, and to tear up tram roads there and elsewhere.

Now, referring to the Tinsbury explosion it would be interesting to know how either flame or heat were kept alive, when the distance from the shot to No. 1 explosion is stated to be 191 yards, and the total number of explosions 18, spread over a distance of 2,614 yards.

In the Camerton explosion, the explosion traveled against the air current, but at Tinsbury the reverse way. How does Mr. Stuart account for this fact?

Another of Mr. Stuart's arguments requires a great deal of elucidation, for he argues that because after the explosion at Clifton Hall in 1885, at Llanerch in 1890, and at Spring Hill, in Nova Scotia, in 1891, the lamps burned in the after damp, that, therefore, the explosions could not have been caused by fire damp. This is certainly a very strong statement and we ought to know what did originate Clifton Hall and Llanerch, if it were not fire damp. As far as the Spring Hill disaster is concerned I can quote from a letter received only a few weeks since from my friend. W. H. S. Poole, of the Acadia Coal Company Limited, referring to this very disaster in the following words "The presence of gas was known, precautions were taken, but they turned out insufficient."

* * *

WHAT ARE THE CAUSES OF MINE EXPLOSIONS.—By Mr. Thos. Hall, Van Meter, Pa. This paper was read before the Western Pennsylvania Central Mining Institute at the December meeting.

Mr. Hall classes the causes of mine explosions under three heads, as

1st.—The use of open lights;

2nd.—The use of defective safety lamps;

3rd.—Shot firing.

The paper noticed the fact that is common to all human conduct, namely, that no steps were taken either in Europe or America to prevent the recurrence of explosions in mines, until the great sacrifice of life cried for prompt attention, and he averred that the amended mine laws of Western Pennsylvania, if fully adhered to, were as good a common sense remedy for the prevention of explosions, as is known. The remarks on defective safety lamps are important, being those evidently, of a prudent, practical man. Mr. Hall says that notwithstanding all the supposed improvements in safety lamps, there remains with us still the old Clanny lamp with his "*new coat*," meaning the bonnet, as seen in the bonneted Clanny or Marsaut, and he thinks it is likely to remain until the electrician displaces it, but he urges that the chief shortcomings of the bonneted Clanny, arise when its use is abused, for he says that neither a man nor a lamp should be allowed in explosive mixtures of gas and air, and even where sudden outbursts of gas may be expected he thinks the self-extinguishing lamps afford the required safety, but the best remedy of all is, not to be satisfied with the minimum ventilation allowed by the law, but to provide a quantity of air sufficiently copious to carry off gas as quickly as it is given off and to dilute it below the ignitible point.

Mr. Hall's remarks on shot firing are excellent, and for point and pungency they are the best we have heard. He says that marsh gas can be removed by a swift current of air, but the danger from coal dust *increases*, instead of diminishing with the speed of the current, and this is the whole matter in a nut shell, and what is true of swift air currents he urges is equally true of powerful explosives, as dynamite contrasted with gunpowder. But he emphasizes the dangers due to the heat developed by black powder in exploding. The paper further urges that practical men ought to provide for increased safety in the mines of Western Pennsylvania, for in working the deeper seams, increased temperatures and greater dryness are sure to be the natural concomitants of increased dust in the air currents of the mines.

The comments on this paper were very interesting and some pertinent questions were asked and answers given by Mr. Hall and others.

MINE MAPS.—By Mr. Ben W. Robinson, M. E. The following is an extract from an article in the Eleventh Annual Report of the Inspector of Mines of the State of Kentucky, 1894, and it is well worthy of special attention:

A good, accurate, carefully made mine map will many times repay the operator for the outlay attached to keeping it in such a way that it accurately represents the workings from month to month, and from year to year.

The map should be a basis from which to make all estimates, such as materials for tracks, timber, drainage and ventilation. It shows how much coal has been taken from a certain block or tract, and how much has been left in pillars. It should be a basis from which to locate all new workings, pumps, hauling machinery, ditches, crossings, air-ways, brattices, doors, and ventilating machinery.

A full and complete map of the surface should be made before the pick of the workman comes on the ground. The boundary lines of the tract should be accurately located, and a convenient base line permanently marked. This map should be filled in with all important details, showing railroads, public and private roads, houses, fences, streams, lines of outcrop of measures, general direction of hills and valleys, and all permanent objects which shall serve as landmarks for future reference. Elevation of all prominent points above a certain datum should be plainly marked.

The underground map should be a complete representation of the works, just as they are. It should show all shafts, all openings to the surface, all haulage lines, ditches and water crossings, faults, brattices, doors, pumps, engines and machinery; should show all places which are worked out, and those working; should show where pillars have been drawn, and where left standing.

All elevations of principal points, such as entry crossings, sumps, etc., should be plainly marked thereon at the proper point. Also, height and character of the roof should be noted.

In connection with the map, there should be kept a profile, showing in detail the levels on the principal entries, grades of existing tracks, water-ways, etc.

I want to say that accuracy is, above all, of the most importance in a mine map. An inaccurate, carelessly made map is not worth the paper that contains it. It is an incorrect basis for estimates, conveys but a general idea of the workings, and, if depended upon for the location of boundary lines, is a producer of endless litigation.

The importance of accurate maps increases as the workings become more extensive and the problems of mining more intricate. The map should be kept co-extensive with the workings, as the parts of a mine which are abandoned soon become inaccessible, and the chain of record is broken.

In making a map, neatness is a desirable feature. While I do not believe in putting any extra flourishes on them, such as delicate shading or elaborate lettering, and while I know that a map of mine workings does not, at best, appeal to the artistic eye, still I think we should have due regard to the workmanship which we put on them. The one idea to maintain constantly in view is to make the map answer its purpose in as simple a manner as possible, avoiding all lines and marks which are not essential to that purpose. Engineers themselves are too prone to place a low standard upon their own work.

Tunnel surveying has reached an almost incredible accuracy, owing to improved instruments, improved methods, and especially to the high standard which is expected for such work; and should not the practice of mine engineering also demand a high standard? A mistake in the alignment of a tunnel would cause financial loss, but a mistake in a mine survey might even cause a loss of life.

The engineering instruments of to-day are being brought to a high state of perfection, which is simply to meet the demand being made by the engineering profession. No workman is able to turn out a creditable piece of work without good tools and of the proper kind.

A good survey cannot be made with a Jacob-staff and a surveyor's chain. These may have answered the purpose for which they were designed, but they have no place in mine work.

It excites our mirth, and also our pity, to see some of the antiquated instruments which comprise the engineering outfit at some of our mines. Good guess work and a good guesser could accomplish equally as good results as could be arrived at by the use of these instruments. Yet, no doubt the manager congratulates himself that he has left nothing to be desired when he becomes the proud possessor of these same instruments.

It is not necessary to enter into a discussion of how a survey should be made, as each engineer probably has a method of his own. Given a good set of instruments, plenty of time, good assistance, encouragement to do his part well, and any engineer who has not mistaken his calling will do creditable work.

It should not be forgotten that permanent monuments, whose positions are shown on the map, should be established. From data supplied with these monuments, every point in the mine should be quickly found, not only after a few years have elapsed, but in years after, when others have taken charge in our places.

When our map is complete it should be a perfect representation of the underground workings. Not only should the engineer make accurate surveys of the work as it progresses, but he should see that the workings are made in the right direction. He should endeavor to educate the miner, the mine boss, and all who have any part in the direction of the work, for this is an absolute necessity, and he should cause them to take not only an interest, but a pride in it.

Finally, the engineer's note book should be regarded as a valuable piece of property, to be taken care of and preserved, and it should be his constant aim to make it so. The notes of all surveys should be classified and indexed, so that any particular point may be quickly found. We should endeavor to leave our business in such a shape that should death call us, or should we move to new fields of labor, another could take up our work where we left it.

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THE LIMITATION OR LOCALIZATION OF COLLIERY EXPLOSIONS.—By James Ashworth, M. E. Taken from the *Colliery Guardian*. One of the most noticeable features in connection with colliery explosions is the vast area of workings and great length of roadway affected by the flame of the explosion. Official reports, even when considered in connection with a plan of the workings, convey no adequate impression of the vastness and completeness of these disasters excepting to those who have actually seen the effects underground. No effect that is ever seen on the surface of the earth, excepting only that of lightning, can in any way convey to the human mind an idea of the enormous power exerted and expended in a very few moments; and it is only by transforming the underground roadways through the mind's eye into some familiar length of turnpike with its many branch roads, that it is at all possible to imagine what sort of force must have been at work to cause a flame to traverse so far without being naturally extinguished by the cooling surface exposed to the flame. Thus, at the Albion Colliery in a very few seconds of time seventeen and a quarter miles of roadway and 4,041 yards of working face, or a total length of 30,000 yards, were devastated, human beings dismembered, doors, trams and other materials smashed into matchwood—and all because our science and engineering have not provided us with an effective restraining agency at the point of origin.

The effects produced have in many cases been so sudden and so unexplainable, that our scientific knowledge of the causes and chemical reactions affecting this subject have been unable to afford a lucid explanation, and they have often been seriously attributed to lightning striking the pit and traversing the roadways—for instance, at Risca in 1880, where every life below ground was lost (120), and at Elemore in 1886, where the flame was seen to pass from a higher to a lower mine down the shaft.

That some means should be discovered by which these accidents can be limited or localized is most desirable, and that the want is universally acknowledged no one will deny, more particularly as the tendency of present-day management is to lessen the cost of coal-getting by increasing the output from one pair of shafts, and therefore to add to the already large number of work-people engaged on each shift. The safety of the whole mine is dependent on the strength of its weakest part, and therefore we cannot say, after the practical demonstration afforded by the Albion Colliery explosion, that the division of a mine into separate districts is any effective safeguard.

What, then, are the palliative measures which are available? First and foremost of these is the total abolition of blasting with gunpowder or any other of the flame-producing explosives, and, in fact, of all explosives which depend for their safety on something which is not incorporated in the explosive itself, such as water-cartridges and flame-quenching mixtures; secondly, the use of water in the form of sprays for damping the intake air-current of the mine, wetting the floor, etc., where shots are to be fired; and lastly, by wet lengths of roadway.

Of all these means the strongest official support and approval have been bestowed on the use of flameless explosives and some form of water-spraying apparatus, although the latter have not as yet been tested by the experience of actual explosion nor yet by any experimental research, excepting by the Prussian Commission. Thus we find ourselves totally without proof of their utility or any justification for the dependence which is now being placed on their efficiency to arrest an explosive flame or to localize the latent forces it is necessary to keep under absolute control.

To show how impotent water-sprays are to effect any localization of explosive effects, it is only necessary to refer to information which has been before us for some considerable length of time. Professor Dixon, who was an active member of the late Royal Commission on Explosions from Coaldust, read a paper before the Federated Institute of Mining Engineers on the rate of explosion in gases, and he there says: "In the detonation of carbonic oxide in a long tube, the oxidation is effected indirectly by means of steam, as it is in the ordinary combustion of the gas. Measurements of the rate of explosion of carbonic oxide and oxygen in a long tube showed that the rate increased as steam was added to the dry mixture, until a maximum velocity was attained when between 5 and 6 % of steam was present." Quoting from Berthelot, carbonic oxide is not combustible when mixed with dry air or with dry oxygen, as may be readily shown by experiment. A jet of carbonic oxide, burning in ordinary moist air, is at once extinguished if a cylinder filled with dry air is brought over the flame.

Only a few weeks ago there was published a most interesting and instructive paper on "Humidity and Temperature Observations at the Maybach Colliery, near Saarbrucken," and the conclusions arrived at are of such great practical importance that no excuse is needed for the reproduction of some of the conclusions arrived at. The temperature of the air-current at the working faces was only lowered 1° Cent. by the spraying.

"It has been observed that moistening the coal dust in deep workings was calculated to diminish the temperature considerably and continuously, and that the danger of fire-damp ignition would be greatly diminished, because it is well known the inflammability of fire-damp, and also the severity of the explosion, increases in direct proportion to the mine temperature. Now, however, that only a temporary cooling of the air is found to be effected by the spraying, it would appear that too great importance has been attached to this practice. In order to determine the action of damp air-currents on coal dust accumulations, samples of coal dust were taken from various places in the field of working, and their humidity found to vary between 2.05 and 3.65 per cent. According to the conclusions of the Prussian Fire-damp Commission, the capacity for explosion of coal dust is only removed when it has taken up 50 per cent. of its weight in water. If it be reflected that the coal dust experimented upon only contained 3.64 per cent. of water at the outside, although it was always subjected to the influence of very damp air-currents, the result follows that even in the dampest mine atmosphere the dangerous property of coal dust is not eliminated.

"It is, therefore, perfectly clear that all methods for rendering coal dust harmless by the artificial introduction of water into the entering air-current are absolutely worthless in practice."

The practical experience of Mr. Martin, of Dowlais, quoted in the Coal Dust Commissioners' report, does not show up the value of spraying in any better light than the practical results obtained at the Maybach Colliery; thus, the reduction of temperature was only 2° F., and there was as much aqueous vapor (7.3 grains per cubic foot) in the air at the working face when the sprays were not at work as when they were at work.

It would seem, with the above facts in view, that it is of the very greatest importance that all the facts bearing on this subject, which affects the daily safety of thousands of miners and a vast capital expenditure, should be taken in hand for collection and collation by some recognized body of mining engineers, such as the Federated Institute of Mining Engineers.

One branch of this subject has already been introduced to the North of England Institute of Mining and Mechanical Engineers in a short paper written by Mr. Simon Tate, of Trimdon Grange, entitled "Saving of Life from Afterdamp: Smoke or Fumes in Mines," which was read at the general meeting at Newcastle-on-Tyne on the 13th of October, 1894. This paper was well received, and although the suggestions thrown out were shown to be impracticable in application to old mines, yet it was allowed that they were applicable to new mines.

In exemplification of the class of useful facts which occur to the writer as bearing on this subject the following have been selected:

At the Albion Colliery no effects of the explosion, excepting afterdamp, were found in the Pantddu dip. It is suggested that this was in consequence of its wet state, but those who saw the place at the time did not consider it very wet, and as the Bodwenarth incline, which is nearly opposite, and is also wet for some considerable distance, did not escape from the full effects there seems to be something here worth careful investigation. One difference observed by the writer is that there are stables at the top of Pantddu and not in Bodwenarth.

That the position of stables may have some influence in arresting the flame effects of a colliery explosion seems to be borne out by the escape of the New East haulage road at Altofts, where the stables are at the top of the road. This is a very remarkable instance, because the top of this road was in a direct line with the West chain road, were the disaster originated, and within a very short distance of where the haulage engine was smashed up, and from which point the flame afterwards traversed the entire length of the No. 1 chain road.

At Elemore there were stables near the Dale Way haulage road, and the flame did not traverse these workings, one man and one boy escaping unharmed; also in the George Hutton seam there were stables near the main road, and seven men escaped unharmed.

It has also been proved on many occasions that a thoroughly wet length of road will arrest the flame of an explosion and limit it to the district in which it originated, as, for instance, at Hyde in 1889, at Apedale in 1891, and at Albion in 1894, and it would appear to be the only practical means of limiting or localizing an explosion at the present time, unless we admit the case of the blown-out shot disaster in the Black Mine at the Ashton Moss Colliery in 1891, where the only restraining influence was the excessive dryness of the mine.

After an explosion the greatest loss of life is caused by the disarrangement of the ventilating air current, and, as a consequence, the non-dilution and escape of the gases produced by the action of the explosive flame and its residual heat. These, if quickly removed or diluted by fresh air, would save the lives of the majority, but unfortunately, as the ventilation of the mine is stagnated by the destruction of doors and air-crossings, the only chance of rescue for those in distant parts of the mine is to build themselves in and depend on the air thus bottled up to sustain them until found by the rescue party.

It has, however, occurred to the writer that a much better plan than this would be to put into operation a remedy which may be said to have stood the test of a very severe explosion, and which suggested itself from an incident of the exploration after the Swaithe Main explosion. A carpenter's assistant had gone down the pit shortly before the explosion, and as neither he nor his body had been found, it was surmised that he might be under one of the heavy falls, and a lookout was kept for any signs of a saw, a hammer, or strips of wood. One party of explorers in passing through an opening found a door completely smashed, and a little farther along another door shut and not in the least injured. On opening this door a saw was found just inside, and many yards up the heading the body of the man. It appeared, therefore, that at the precise moment of the explosion the man had the door wide open, and that the same force which smashed the first door threw him on to his face many yards through the second doorway, and that the door had then quietly closed behind him. Probably this small incident would have been the means of saving a great many lives in the boundary bord, had not an air-crossing close by been completely destroyed. This incident proves that if we provide a door which is always standing open between two or more closed doors, and so arranged that the smashing of one of these will close it, there is no secondary force which will disturb it, and the air-current will automatically, and after only a very temporary disarrangement, revert into its proper direction. Thus, men who would succumb for want of a little fresh air might be revived, and the time which always elapses between the moment of an explosion and the arrival of a rescuing party will not prove so fatal as it has done in past time. If, in addition to this precaution, all important air-crossings are constructed in the solid strata (as at Albion, where all of this class stood firm), all permanent stoppings made of brickwork backed by dirt or rock, and with wet lengths of roadway at important junctions, we shall be better fortified against the possibility of a huge disaster than we are at the present moment.

There is doubtless something important still to discover to show why roads which are not haulage roads are almost universally exempt from being traversed by the flame of an explosion, and it can only be by the closest observation of hygrometrical, electrical, chemical and other differences that any lucid light can be thrown on this exception, and the writer would therefore commend this part of the subject as being also well worthy of the earnest attention of all mining institutes.

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CONCENTRIC ELECTRIC WIRING SYSTEM FOR MINES.—At the opening meeting of the present session of the Institution of Electrical Engineers Mr. S. Mavor read a paper descriptive of of "Concentric Wiring" for electric light installations. The following is an abstract of the details of the system and its applicability to mining work, taken from the *Colliery Guardian*:

The method of concentric wiring is based upon a full recognition of the fact that electric light wiring, in order to be permanently durable and reliable, must be impervious to moisture. The main switch board has the usual single-pole switch and fuse arrangement, and the board is surrounded by the negative omnibus bar, which receives in sockets attached to it the outer conductors and sheathings of the concentric cables. The main cables, which are lead-sheathed throughout, and are generally armored with galvanized iron wires laid over the lead on a cushion of jute, are carried without break or joint direct to their respective distributing boxes, where the central conductors are soldered to the omnibus bars, and the outer conductors terminate in gun-metal sockets secured to the boxes. The distributing boxes are of cast iron or cast brass, enameled white inside, and fitted with fuses, or switches and fuses, as required. These boxes have close backs and hinged fronts closing upon an india rubber ring, thus rendering them proof against dust or moisture. The concentric branch cables which radiate from these boxes are under all ordinary circumstances of uniform section—namely, 7/21½—equal in area to 0.005 square inch. The outer conductor of the cable has the same section of copper as the core, and the whole is enclosed in a solid-drawn tube of lead. Whenever a joint is to be made, or the cable led into a switch or fitting base, the center wire is soldered to its contacts, and the outer conductor and its lead sheathing are received and terminate in a jointing pocket cast upon the switch-box or junction. The central wire and its insulation are thus enclosed throughout their length in a hermetically sealed metallic sheathing. The section of the branch conductor 0.005 square inch is carried into every switch and into every lampholder, no reduction being made. There is no necessity for any fuses other than those in the cast iron fuse-boxes, and these are all uniform and interchangeable. It is very rarely that occasion requires any departure from this plan. Many large installations have been carried out on the lines indicated, some of these amounting to several thousands of lamps, where only two sizes of fuses—main and branch, respectively uniform and interchangeable—have been used. The simplicity and reliability of such a system must be too obvious for emphasis.

The branch cables are led through buildings like flexible gas pipes, but they are not liable to damage as composition gas pipes are. The conductors and the insulation within the lead sheathing serve as a backing for the lead, so that it is not at all easily damaged.

In support of the claim that this method of wiring is reliably waterproof, the case of Messrs. Nobel's Explosives Company's West Quarter Factory may be cited. The buildings to be lighted are isolated and scattered over a large area in order to reduce the risk and minimize the effect of explosions. The regulations issued by the Home Office regarding electric lighting were so very stringent that it was impracticable to comply with them except by the use of concentric wiring. With concentric wiring everything was made easy. Its waterproof and fireproof properties overcame all the difficulties. Every joint and every yard of the conductors is outside and exposed to the weather, cleated for the most part to the gangways. The switches, of cast brass, and distributing boxes, of cast iron, are also all outside, protected only by water-sheds. The work of wiring was completed more than three years ago, and, notwithstanding three years' exposure to the elements in this climate, the insulation resistance is as high as ever. Monthly tests of the insulation are required by the Home Office, and on the 10th of October the insulation resistance was two and a-half times higher than the most stringent of the fire office rules require for indoor wiring. In the nitrating department of the same factory, which is a quarter of a mile distant from the other installation, the insulation is equally satisfactory, although the wiring is subjected to the profuse fumes of nitric acid. It is noteworthy that the insulation of the wiring at both these places is not india rubber, but is fibrous. The exclusion of moisture is therefore solely due to the lead sheathing and waterproof nature of the joints.

For mining work, concentric wiring is specially adapted. The mechanical nature of the fittings, and the ease with which they and the conductors may be made waterproof, are important features. A concentric cable for mining purposes is more safe than two separate cables. A fall of material from the roof may rupture one of two conductors, and if current is passing, the inevitable result is a spark at the point of parting. In fiery mines this might have serious consequences. With a concentric conductor, however, the fall would crush the outer conductor in upon the core, and so cause a dead short-circuit and melt the fuse before the cable parted. The spark would thus take place at the fuse at the pit bank. In the only case of such accident within the writer's experience the fuse did promptly melt. Several devices have been proposed for the purpose of preventing a spark at the point of rupture of cables used in pit work. There is room for doubt as to the liklihood of these devices performing their functions in case of need. There can be no question that the concentric cable is much more simple, and it is probably more reliable than any of them. Further, none of these arrangements afford to the miner the immunity from personal danger from shock which the concentric cable does. An E. M. F. of 500 volts is frequently used for such work, and it is usually considered that such a pressure, although sufficient to give a disagreeable shock, is not dangerous to life. That this feeling of security is not well founded is unfortunately proved by recent fatal accidents. For power transmission in mines an ideally safe system is furnished by concentric cables with earthed sheathing, and switches, fuses and other appliances enclosed in cast iron cases, also earthed, and, if need be, enclosed-type motors with their castings earthed.

* * *

GERMAN TRADE AT HOME.—Taken from *Kuhlow's German Trade Review and Exporter.* At the general meeting of the Society Versuchs-und Lehranstalt fur Brauerei in Berlin, Goslich read a paper on this subject, the most important details of which are here reproduced. A large quantity of brown coal, appraised at some 200,000 tons per annum, is consumed in the breweries of Berlin alone, and another 80,000 tons or so in other industries, but up to the present the earthy brown coals found in Anhalt, Saxony and the Lausitz district have only been available for use in step-grates, on account of their high (50 to 60) percentage of water, in crude state, and the increased expense of carriage due to this cause. To remedy this it has been proposed to first dry the coal and then, in order to prevent loss in the shape of dust, and render the coal suitable for use in ordinary grates and furnaces, to compress it. This pressed coal has begun to compete with the Bohemian brown coal, but the blocks are unfortunately very badly made, a condition due both to the nature of the raw material and the method of manipulation. The coal is obtained from surface workings and pits, the former when the circumstances are favorable—*i. e.*, when the cover earth can be cheaply removed—and in these cases the coal, having been exposed to but slight pressure by the small amount of overlay, is not so compact as that obtained at greater depths. Furthermore, this surface coal is generally impregnated to a depth of a couple of yards with sand and other matters forming dross and ash when burned, and, consequently, when these upper layers are not kept separate from the lower a more drossy and ashy product is obtained than if the latter were used alone; wherefore pit coal must be considered as better than surface coal.

The value of compressed coal also depends on the way it has been treated in the manufacturing processes of drying and pressing. The first-named operation is carried out in kilns, either flat or cylindrical—the latter for choice, as giving better results, since the more completely the drying is effected, the less water remains behind, and consequently, the greater is the pressure required to form the coal into a cohesive mass. Only, therefore, those collieries that possess sufficiently powerful machinery for the production of the necessary enormous pressure can carry on the drying process very far, and these work at about 1,500 atmospheres pressure. The older works, where the manufacture of blocks has been established for some considerable time, being without such machinery, and disinclined to discard what they have, are constrained to leave a comparatively large amount of water in their coal to be able to produce the compressed article at all.

There is no product or manufactured article exhibiting such variations in price, or with which the public is so deceived, as compressed coal, both as regards quality and quantity. There are some works where only surface coal is manipulated, and only an inferior article is produced; in others, again, half surface and half pit coal is used, whereby a better quality product is turned out; and, again, there are some where only best pit coal is used, and consequently, the best article, commanding a good price, is made. The latter have their own trade marks, which are, however, imitated as closely as possible by the manufacturers of inferior goods, so that it is very difficult for the consumer to find out which is the best. Another practice, opening a wide door for deception, is that of making blocks of different sizes—some makes will go 35,000, while others are only 18,000, to the wagon load—particularly as retailers always sell by number instead of by weight. The desire on the part of consumers is to have a clean, bright-looking block, for which they will pay a higher price, although these external indications have no connection with the quality or calorific value of the coal, but merely increase the cost of manufacture.

For industrial purposes, small cubical blocks are the best to use, being easier to shovel up, and burning regularly in the furnace without falling to pieces. No concern need be had for smooth surface and clean edges, these being luxuries, and unconnected with the quality. It is, however, well to see that the coal is dry and leaves but little dross or ash, and these properties are not discernible to the eye, but must be made the object of experimental determination.

A number of coal blocks examined in the laboratory for ash and water content exhibited marked individual differences in these respects, the best coal tested having 9.5 per cent. of water, while the worst held more than 18 per cent., a difference of 50 per cent. in value. Again, one coal contained 5.8 per cent. of ash and dross, whereas in another 11 per cent. was found. The best Bohemian brown coal tested for the sake of comparison gave 13.13 per cent. of water, another 19.09 per cent., while ordinary qualities exhibited a content of 24 to 30 per cent.

* * *

TRAP DOORS FOR FAN DRIFTS.—Work has been in progress for some time past on a new fan at the Hoyt shaft of the Pennsylvania Coal Company, and it is now in operation. The mine is quite gaseous, and it was deemed advisable to erect the new fan for use in case of emergency or in conjunction with the old fan. The fan house is of brick almost entirely, the girders in that portion where the air circulates as it comes from the mines being of iron, inlaid with brick. The fan itself is twenty feet in diameter, and it has a capacity of about 144,000 feet of air each minute. Several features of the plan of the new fan are of special interest, by reason of the fact that they are here adopted for the first time by the Pennsylvania Company. There are two brick passage-ways through which air is drawn from the shaft to the fan, and at the entrance to each of these passages is a massive iron door. One is 14x4 feet in size and the other about 14x5. These are so set on upright axles as to work automatically if anything should occur to stop the fan. Thus, if the new fan should be injured, the old fan would be started and the change in the current of air would of itself be sufficient to close the iron doors leading to the idle fan, and *vice versa*, since it is the intention of the company to place a similar arrangement in the old fan. Should the doors fail to operate automatically, levers running from the engine house will enable the engineer to open or close the doors with but little effort. The idea is to make it possible to change from using one fan to the other with the least possible delay. It is hoped, too, that the two fans will work together, if such be desired. In a Wilkesbarre shaft a somewhat similar arrangement is proving very satisfactory. The new fan will be an important addition to the equipment of Hoyt shaft, and its operation is being watched with interest by the company's officials. The fan has been in operation for several days in order to get the machinery working smoothly, but has not yet been connected with the shaft.

* * *

THE ENGINEERING ASSOCIATION OF THE SOUTH.—This association, besides its regular meetings for the reading of papers, discussions on the same, etc., holds informal meetings, when the contents of leading technical publications are discussed by members, to certain of whom are assigned a particular journal. At an informal meeting held Dec. 26, 1895, the following assignments were made: *Engineering Record*, to Mr. Ruhm; *Engineering*, (London), to Prof. Schuerman; *Scientific American Supplement*, to Maj. Locke; *Colliery Engineer and Metal Miner*, to Mr. J. J. Ormsbee; *Engineering News*, and *Journal of the Franklin Institute*, to Mr. Kirkpatrick; *Railroad Gazette*, to Mr. W. N. McDonald; *Engineering Magazine*, to Mr. Geo. F. Blackie; *Stone*, to Mr. J. S. Walker; *Journal of the Association of Engineering Societies*, to Capt. Biddle; *Iron Age*, to Maj. Lewis; Mechanical and Electrical Engineering Literature, to Prof. Magruder; Architectural Literature, to Capt. Smith; Reports of the American Society of Civil Engineers, to Mr. H. McDonald; *Engineering and Mining Journal*, to Lucius P. Brown; The Literature of the English Iron and Steel Industries, to Mr. Lodge. An interesting discussion of a recent paper in the proceedings of the American Society of Civil Engineers was opened by the President. The paper was entitled "The Life of Iron Bridges." Among other things, the author of this paper took the position that the "Factor of Safety" now usual was too high. The general opinion of the members present, however, seemed to be against this view, because of the slight advantages to be gained by a change, which were reduced to a minimum when compared with the consequences of any accident that might follow such a change.

* * *

A NEW SAFETY EXPLOSIVE.—From the Science and Art of Mining. Prof. F. Kleinpeter draws attention to a new mining explosive which is said to be coming into vogue in Austria. It is known as Dahmenite A, and is said to be 33 per cent. stronger than the best gelatine dynamite, and in consequence of the large volume of gas which it produces (being approximately double that yielded by dynamite) it has a wedging rather than a pulverizing action resulting in a materially increased fall of lump coal. It can be compressed without losing any of its explosive force, and in this state, far surpasses every variety of dynamite. A much weaker detonator is required to bring it to explosion than is required for any other known safety explosive, and it is better able to withstand the effects of storage. If properly packed no decomposition can take place. The last illustration of the safety with which Dahmenite A can be handled is the fact that the German Board of the State railways allow it to be carried in any trains, even in mixed passenger and goods trains. Extensive experiments are in progress in the several mining districts of the country, and when these have been completed no doubt we shall hear something further of the nature and properties of the new explosive.

Foreign Orders for American Electric Plants.

That the product of the Westinghouse Electric and Manufacturing Company is of world wide demand has again been demonstrated, recently, by the company receiving orders to equip an electric railway in the "Isle of Man," the little island near the coast of Ireland, which has been made famous by Hall Caine, the great novelist; another order for electric railway apparatus for the City of Coventry, England, and a third order for electric motors and railway generators for Capetown, South Africa. The company is also about to ship an order for electric railway apparatus to Bangkok, Siam, India.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

*** The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING METHODS.

Accumulations of Gas—How to Approach Accumulations of Gas—How to Remove Gas—Underground Fires—A Gob Fire in a Mine—Fires in Coal Heaps—The Breathing of a Gob.

80. Accumulations of Gas.—Sudden accumulations of gas are often the results of causes that can be predicated from known conditions, such as when gas is pent up *in situ* at a very high pressure in a thin vein that lies at a few feet above or beneath the working vein; for here it is easy to foresee that sudden intrusions of gas may be expected in the rooms, by finding a passage through open fissures that are uncovered during the extraction of the coal, or the pent up gas may be expected to break the roof, or lift the floor, and thus find vent into the working places. Sometimes the working vein is a reservoir of gas at a very high pressure, and especially so in virgin coal that is in course of being tapped in new districts, for here sudden outbursts of gas occur that derange the ventilation, and yet the outrush may be no surprise, but an expected event. Again, during the course of longwall working, the covering rocks forming the roof often break up into coal pipes, or thin seams of coal, and make open channels for the outflow of large volumes of marsh gas, yet the outrush of the gas may be foreseen in this as in the other cases, but there are cases in which sudden accumulations of gas are totally unexpected, as when, during the course of working, the vein is found to be cut by a fault that pours out a flood of marsh gas and sulphureted hydrogen. Our greatest concern should not, however, be to assure ourselves of whether the outburst was unexpected or not, but to remove the danger by a correct method in the ventilation, and this conclusion brings us to the practical point in the lesson, for seeing that we have shown the causes of the accumulations, we ought now to be able to remove the intruder and render the mine healthy and safe, and in doing so the following dictum should be taken as our guide. "Advance to the point of danger with the fresh air, but never go in before it."

81. How to Approach Accumulations of Gas.—To assist in establishing this conclusion Fig. 123 is introduced, and it will be seen that the sketch is a good illustration of the principle that has just been insisted on. Here the point of danger occurs at *P*, where there has been a great fall of the roof, and an outrush of gas, and as this has taken place at an elevated point we may be sure that the gas will not be carried off unless a sufficient ventilation is provided, and as this cannot be done until the obstruction of fallen rock is removed, it would be unwise and unsafe to do otherwise than obey the commands of the dictum, and "advance with the fresh air" to the point *P*, for should we advance to the rear of the fall as at *F*, we would have to proceed by way of *G*, *G*, *G*, through a dangerous mixture of air and marsh gas, and such a proceeding would be inexcusable, even for an inspection, but to send the workmen in by the road *G*, *G*, *G*, to clear away the fall and secure the roof, would be a great mistake, because they would have to advance through the off-coming gas, and work in it until the work was done. No person should be allowed in the return airway *G*, and the fall could be better removed and with perfect safety by placing the men in *A*, *A*, *P*. There is one thing however about this illustration that is self-evident, and that is the comparative ease with which the right method of proceeding can be carried out, but there are other cases in which sound judgment and practical experience are required to secure the results of safety, and such is the one that will next engage our attention, and to explain which we will use Fig. 124.

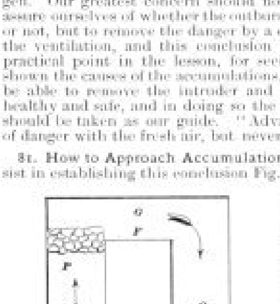


Fig. 123.

82. How to Remove Gas.—Suppose a room that is in course of being driven, and is ventilated with a brattice that confines the ingoing fresh air to the narrow side, as shown on the right hand side of the figure; a practical eye can see at a glance that this arrangement is a mistake and ought to be rectified, or otherwise the workmen would have to do the clearing away in an atmosphere highly impregnated with inflammable gas, and therefore the direction of the ventilating current should be reversed as it is at *I* on the left hand side of the figure, for this arrangement would carry the gas from the men, instead of to them, and would thus secure perfect safety. To carry out the latter plan a small temporary crossing like that shown at *c* should be fixed, then the fresh air would enter the room by passing under the crossing, and the return foul air would leave the room by being carried over the fresh air by the crossing. We see then that the fixing of this crossing is the result of the exercise of sound judgment, such as can be cultivated by training and observation.

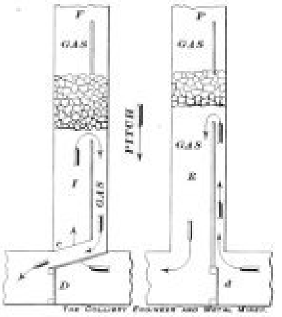


Fig. 124.

83. Underground Fires.—Many of the most brilliant feats in mining, however, have been the results of educational training, and indeed they could not have been carried out without knowledge, and to show the kind of culture the miner requires, let us notice some of these often occurring cases and take the teachings of Fig. 125 for a first example. Here we will see that at any rate, an elementary knowledge of the chemistry of gases, and the expansion of gases is required to deal with the conditions of the case, and to prove the accuracy of our statement, let us first explain the figure. We are supposed to have the coal on fire about the middle of a coal drift, and we are appointed to stopping it off, and we know by the painful experience of others that if the wrong stopping is built in first we are *sure* to have an explosion. It is therefore imperative that we should know what we are about, and for that to be so, let us notice that the locality of the fire is in the middle of the drift as at *H*, *H*, and that both the drifts, that is *A* and *B*, are different examples of treatment for the same drift, and that before the stoppings were built the air was moving from *B* to *R*, or from *F* to *X*, and, as has frequently happened, if the stopping *F* is first built to cut off the entry of fresh air, as in the case of the drift *A*, an explosion is sure to occur as the result of two causes: first, the large volume of inflammable gas driven off by the heat, and second, the expansion by heat of the air between the stopping at the intake end of the drift and the fire. The cause of the expansion of the air between the stopping and the fire, is the heated state of the rock of the roof and floor and the coal of the sides of the approach to the fire; and the immediate cause of the explosion is, the expanding air does not only mix with the gas, but it still further forces the mixture into the fire. When the stopping at the return end of the drift is built in first, as shown at *R*, an explosion cannot occur for two reasons: first, the air between the fire and *R* consists of the products of combustion that have become entirely inert, while the space in the drift between the fire and the incoming end becomes filled with dead gases and the gas given off in great volumes by the hot coal, and the result is, when the last stopping is built in, that is the one at the incoming end *F*, the whole drift is filled with gases that have excluded all fresh air, and therefore an explosion cannot now occur. Notice that the seat of the fire is at *H H*, and that when *F* is built first the fresh air between *F* and *H H*, or *E I*, supplies the oxygen for combustion, and that if *R* is built in first, not only the *R* but the *B* end becomes filled with gas free from any admixture with oxygen. The arrow at *B* indicates the outflow of gas from the fire, and the arrow in *A* indicates the course of the ventilation before any stoppings were built in.

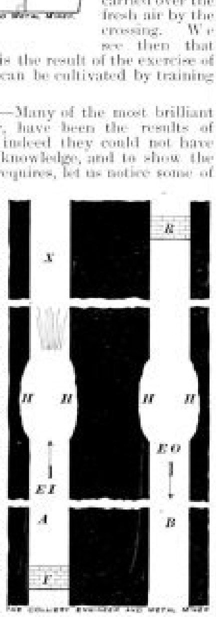


Fig. 125.

84. A Gob Fire in a Mine.—After these facts and principles have been considered we cannot fail to learn that some technical knowledge is required in mining, and it is the object of the "Easy Lessons" to aid in obtaining it. Fig. 126 teaches another lesson on underground fires, and here it has occurred in the gob, and as is generally the case the coal is supposed to be on fire, and from what has been said in relation to the former figure we might suppose that all we require to do is to "stopping off the fire" and it will die out, but our experience has proved that such a simple proceeding oftener fails than succeeds, and at first sight this seems a puzzle, for we would expect that a fire that was not supported with a continuous indraught of pure air would die out through lack of oxygen to support combustion, but our idea is that of a continuous stream of air, and it is true that there cannot be a continuous supply of oxygen to a fire that is stopped off, but where a large mass of fuel like coal or coke is in a state of incandescence and isolated from cooling influences, it will retain its heat for long periods, and the result is "the breathing of the gob" supplies the oxygen to continue the combustion, and the intermittent supplies of oxygen excite a corresponding intermittent activity of the fire, and it may, as it often does, continue for many years. It is not sufficient then that the gob is stopped off at *A*, *B*, *C* and *D*, because the gob will then inhale and exhale through fissures in the rock of the roof and floor and of the coal walls, and thus not only receive supplies of oxygen, but expel the inert products of combustion.

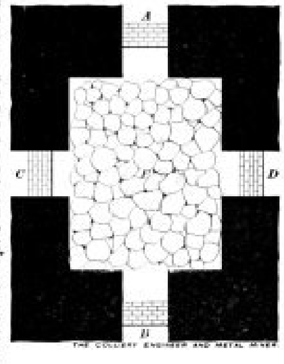


Fig. 126.

Not only are mine fires supported by the process of inhalation and exhalation, but the same active principle applies to fires in heaps of coals and cinders, and we have known large heaps of cinders to take fire many years after they were deposited.

85. Fires in Coal Heaps.—The writer knew a very interesting case at Mill Dam, South Shields, England, where an immense mass of furnace ash from a glass works had been deposited to level up a valley, and on the site many blocks of expensive houses and a theatre were built, and long after the property was completed, and drains were made, and gas and water pipes were laid, the mass of ashes and cinders was found to be on fire, and it continued to defy all attempts to extinguish it, until the whole of the houses and the theatre were destroyed.

Such examples of underground fires, that have smouldered for years, and yet have given no reason for alarm until a period of increased activity arrived, suggest to those that do not understand the "breathing of the gob" that the oxygen for combustion must be supplied by some cunning or mysterious process; but to us miners something more definite must be understood than the mere statement of vague terms, and therefore to unveil the true cause Fig. 127 is introduced.

86. The Breathing of a Gob.—The natural process is difficult to imitate because it furnishes a vast mass of incandescent matter that can retain its heat during the exhalation, to rekindle the fire at the period of inhalation; but by the use of the apparatus shown in the figure, the whole principle of action can be so far imitated as to leave little to be desired. But before explaining the action of the apparatus let us first explain how an underground fire breathes. First, then, inhalation is produced by the condensing of the gas that is in course of being cooled in the region of the fire, when the outside air rushes into the depression to restore the balance of pressure, and by the same act the inrushing oxygen rekindles the fire. The second phase of the matter is this, the renewed activity of the fire causes an evolution of gas, and the heat generated causes a considerable expansion of the products of combustion,

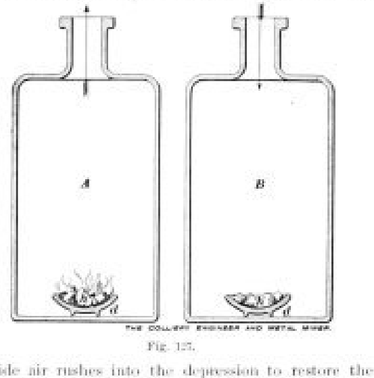


Fig. 127.

with the result that a large volume of the inert gas is expelled as an exhalation, and the remaining portion on cooling, shrinks and makes a depression for the succeeding inhalation. Now let us take the figure in hand, and first notice that two bottles are shown, but really they only illustrate opposite phases in the breathing, and it will now be understood that *A* shows the period of exhalation, as seen by the arrow, or really the period of expansion by heat, and *B* illustrates the period of inhalation, or the period of condensation by cooling; the fire is imitated by a piece of phosphorus lying in a saucer that rests on the bottom of the bottle, and the phosphorus is used as fuel because it rekindles at a low temperature on the admission of a minute trace of oxygen.

Now let us follow through a cycle or two the processes of inhalation and exhalation. First, then, fresh air has entered *A*, and on the free oxygen of this inhalation reaching the hot phosphorus, that substance bursts into flame and expands the air, and by this expansion the nitrogen is exhaled, and after all the oxygen is burnt off by the phosphorus, combustion ceases as in *B*, and then the remaining gases cool and contract, when fresh air is at once inhaled, as shown by the arrow in the neck of *B*; and so on, inhalation and exhalation occur in continued succession, until the phosphorus is all consumed. The bottle experiment furnishes a good illustration of the breathing of a gob, but we can better understand the matter when we consider the immense body of incandescent coal or cinder that retains the heat for rekindling the fire at each inhalation of a gob fire.

Underground fires in coal mines inhale through fissures in the roof and floor rocks, and through cracks, fissures and cleavage spaces in the coal barriers, and therefore it is seldom, indeed, that the breathing of the gob can be prevented.

(To be Continued.)

CHEMISTRY OF MINING.

Oil and Gas Lights—Oil-Gas Flames—Ideal Safety Lamps—Improved Safety Lamps—The Stephenson Lamp—The Jack Lamp.

83. Oil and Gas Lights.—From a physical and chemical point of view, the oil light is really a gas light and the wick is the gas generator, or the analogue of a gas retort in which the liquid oil is distilled or converted into vapor by the heat of the flame. In proof of this, a simple experiment may be tried with a small pipette about 6 inches long, and held by the hand at an angle of about 45 degrees of elevation, with its lower end inserted in the flame just over the upper end of the wick; gas will then ascend the tube, and can be lighted at the upper end and thus prove that the oil is not burning as a liquid, but as a gas.

The oil ascends the wick by capillary action and therefore, the velocity of combustion is limited by the rate at which the oil can ascend; and by the rapidity of the vaporization of the oil; and this being so, we can see that a thick glutinous oil will retard capillary action, and further, while it prevents the upflow by its thickness, it is an oil that burns languidly, and therefore the heat of the flame is not sufficient to generate the required volume of gas for a good flame. This is proved by the facts of experience, for when the wick is raised, the flame only enlarges for a moment or two, when the wick becomes encrusted with a shell of carbon, and then the volume of the flame becomes less than before.

The wick then furnishes a good guage of the value of an oil for the generation of light; and further, the facts now before us, suggest others of greater importance in relation to the miner's safety lamp, and of which we will treat further on, and for the present, let us sustain our conclusions so far by introducing Fig. 124.

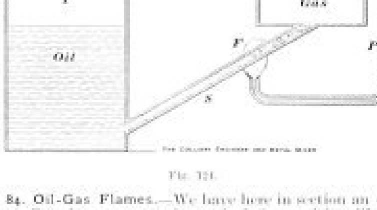


Fig. 124.

84. Oil-Gas Flames.—We have here in section an oil tank *T*, and a gas reservoir marked *Gas*, and it will be seen that the bottom of the reservoir is set level with the upper surface of the oil in the tank, and the two are connected by the sloping pipe *S*. A pipe *P* is seen to convey the gas from the reservoir to the flame at *F*, and the mode of action is as follows: The heat of the flame converts the oil in the upper portion of the pipe *S* into vapor, and while the gas continues at the temperature of vaporization, it flows through the pipe *P* to the flame.

We see then that some of the heat of the flame is utilized for the distillation of the oil, and therefore there is much in the physical and chemical action of this apparatus that has its analogue in the action observed in the common oil lamp, and yet there are two very distinctive differences; for example, the pipe *P* is not an analogue of the wick of an oil lamp, because the wick acts by capillary action that only applies to liquids, whereas the pipe *P* is a gas pipe and the vapor is forced from the reservoir to the flame by pressure. The second difference is a very interesting one, and it is this: The vapor of an oil such as is used in wick lamps only becomes a gas at a high and invariable temperature, and for illustration let us take the temperature of vaporization at 240° F, and we will find that just as steam condenses into liquid water the moment its temperature is reduced below 212° at the ordinary atmospheric pressure, so does the gas or vapor of the oil condense into liquid oil the moment its temperature is reduced below 240°F at atmospheric pressure, and it is for this reason that an apparatus like the one illustrated in the figure, could not be taken as a substitute for the wick of the oil lamp. The reservoir and gas pipe would have to be maintained at a high temperature to retain the oil as vapor, whereas the wick just exposes the liquid oil to the heat of the flame, at the very point where the gas is wanted, and the vapor is therefore generated without any waste of heat, by radiation. From what has been shown we see that if we wish to improve the miner's safety lamp, we must begin our studies by first mastering the principles of the physical and chemical action that takes place in burning oil and gas in a safety lamp.

85. Ideal Safety Lamps.—This brings us directly into the teeth of the question, and therefore to help to further elucidate the matter Fig. 125 is introduced, and to prevent complexity in the explanation one ideal lamp *F*, consists simply of an oil fountain and gauze cylinder, and the other *P C*, etc., consists of the oil fountain, gauze cylinder, and a bonnet, or shield, or close cylindrical shell. The *F* lamp is of the original Davy type, and it is here given as a useful lesson on what takes place when the Davy is exposed to a draught, or air current, charged with marsh gas. In such a situation the lamp is seen to be filled with flame *F*, for the current of air acts like a blast, and the quantity of air entering within the gauze is out of all proportion greater than what would simply enter as a normal draught to feed the flame. By the arrows the explosive air is seen to enter the lower half of the gauze shell, while the burnt air is seen to be leaving by the upper half, but in a swiftly-moving current, when the lamp is stationary, or when the lamp is moved in the hand say at six miles an hour, as when the man's hand is moving faster than his body, as the result of the swing of his arm, and when in addition to this six miles the current is moving to the carrier's face with a velocity of 15 feet per second, the lamp advancing against this current is subject to a blast, whose effect is that of a velocity of 15 + 8.8 = 23.8 feet per second; the blast of air therefore enters one side of the gauze and leaves by the other, with the result that the gauze on the lee side, or that on which the flame is blowing, becomes red hot, and at once "passes the flame through," because the volume of flame within the lamp, as the result of the breach provided by the *naked* gauze, is exceedingly greater than that of a "jacketed lamp," and among other reasons, this is one for the Davy lamp being "a good detector of gas." In the other lamp, at the left hand side of the figure, a Davy lamp is shown with the gauze covered with a close shell, on one side of which is a glass pane for the passage of light, but this is not shown in the section, and this is in principle what the English miners call "*the Davy in a can.*"

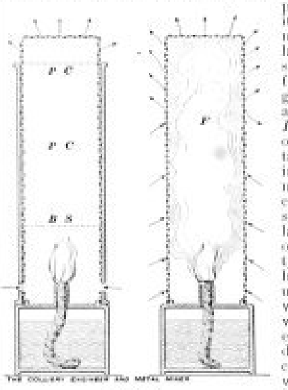


Fig. 125.

86. Improved Safety Lamps.—The safety of this lamp in a can or case is undoubted, so far as protection from fire damp is concerned, and the only objection to this encased lamp is that "it gives a bad light." It will be seen that no more than the normal volume of air necessary for the combustion of the oil enters this lamp, and at *B S* we have the limit of the combustion of the oil, as in the case of the Marsaut lamp, and above that line we have only *P C*, or the products of combustion. The true "*can*" does not fit the gauze so closely as does the shell in the figure, and further, the fresh air enters the can, at the top, instead of at the bottom, the result is the cold air sinks down the outside of the gauze to keep it cool, while the hot burnt air ascends to the cap within the gauze.

87. The Stephenson Lamp.—Stephenson had an experience that served him well in the invention and perfecting of his lamp; and his, one of the first lamps, was provided with a glass shell, shown by Fig. 126, in section at *G* and *G*. A glass cylinder was here set within the gauze, and the result was this inside close shell was a channel for the outflow of the products of combustion only, while fresh air was admitted through small hair-like holes situated in the bottom of the frame of the lamp, and the burnt air escaped by the cap of the gauze under the tile. In theory this was a good lamp, so far as the principle of action was concerned, but in practice it proved to be, when the glass cracked, a very dangerous one; because the gauze cylinder was of a relatively large diameter to admit the glass shell, and the result was with a broken glass it was in principle a Davy, with all the bad features of that lamp magnified. The air is seen to enter by the capillary holes at *A* and *A*, and to pass out of the cap *C* as shown by the arrows.

88. The Jack Lamp.—Fig. 127 is an illustration of the further development of the early improvements in the miner's safety lamp. Jack saw that in principle Stephenson was right, as have all succeeding improvers, in providing a closed shell as a protection against the rapid inrush of an explosive mixture into the lamp, and he also was aware of the dangers arising from the breaking of the inside glass cylinder, and therefore he improved the Stephenson lamp by reducing the diameter of the gauze cylinder and placing the glass shell on the outside, as shown in section under the letters *A* and *A*; and at *G* and *G* we have the poles that support the tile and keep the gauze and glass cylinders in position. Now looking at the various phases of the safety lamp retrospectively, it is very easy to discern that the Clanny lamp, one of the first introduced, which was coincident with the introduction of the Davy and the Stephenson, contained the essential principle of all the latest lamps,

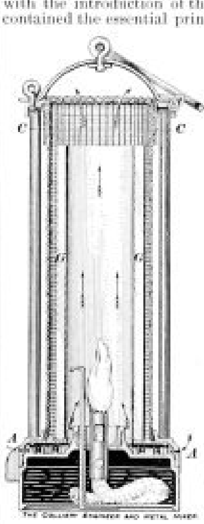


Fig. 126.

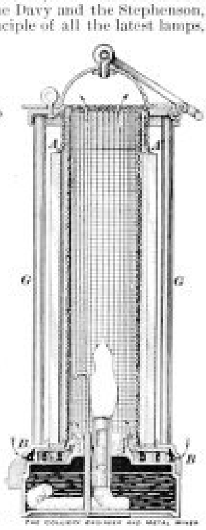


Fig. 127.

namely, the short glass cylinder for the transmission of light; and the Stephenson and the Jack lamp contained the other essential element of the best lamps in use, and that was the close shell, but in the improved lamps the glass shell is replaced with a metal one, and is now called the bonnet. We may therefore conclude correctly, that the latest and best lamps are a combination of the most essential principles found in the earliest examples of miner's safety lamps.

(To be Continued.)

MINING MACHINERY.

Questions and Answers About Fans—The Dimensions of Centrifugal Fans—Velocities of Air Currents Into Depressions—The Areas of the Orifices of Intake and Discharge—Pressures Due to the Radial Columns—Quantities and Velocities of the Air Discharged—Calculations of the Working Efficiencies of Small and Large Fans—Calculations of the Useful Effect of Fans on the First and Second Motion.

103. The Dimensions of Centrifugal Fans.—This is the concluding lesson on the principles of action of the centrifugal ventilating fan, and it consists of questions and answers to elucidate the subjects that have been treated in relation to these machines.

QUES. 1. What should be the diameter of a centrifugal ventilating fan to obtain a quantity of 200,000 cubic feet of air per minute?

ANS. By the rule, divide the quantity by the constant number 200 and extract the square root of the quotient, and the result will be the diameter of the required fan in feet, as $\sqrt{\frac{200{,}000}{200}} = 31.62$.

QUES. 2. Suppose the velocity and other things to be the same as in the former question, What quantity would you expect to obtain with a fan 31.623 feet in diameter?

ANS. By a process the converse of that for finding the diameter, the quantity may be found, as $31.623^2 \times 200 = 200{,}000$ cubic feet of air per minute, the quantity required.

QUES. 3. What should be the diameter of a first motion, centrifugal fan to obtain a quantity of 80,000 cubic feet of air per minute?

ANS. $\sqrt{\frac{80{,}000}{200}} = 20$ feet, the diameter of the fan required.

QUES. 4. What quantity of air in cubic feet per minute should I obtain with a first motion fan 20 feet in diameter? The velocity and other things remaining as in the former question.

ANS. $20^2 \times 200 = 80{,}000$, the quantity of air required in cubic feet per minute.

QUES. 5. What should be the diameter of a fan on the first motion, to obtain a quantity of 125,000 cubic feet of air per minute?

ANS. $\sqrt{\frac{125{,}000}{200}} = 25$ feet, the diameter of the required fan.

QUES. 6. What quantity of air in cubic feet per minute, could be obtained with a fan 25 feet in diameter? The velocity and other things remaining the same as in the former question.

ANS. $25^2 \times 200 = 125{,}000$ cubic feet, the quantity required.

QUES. 7. What should be the radial length of the blades of a centrifugal fan, on the first motion, and constructed to give a high efficiency at a moderate speed, when the mine resistance is equal to 2 inches of water gauge?

Ans. By the rule given, there should be 7 inches in the radial length of the blades for every pound per square foot in the mine resistance, then $\frac{2\times5.2\times7}{12}=6.07$ feet, the radial length of the blades required.

Ques. 8. The radial length of the blades of a fan is 6.07 feet. What should be the mine resistance in pounds per square foot to run a fan on the first motion at a moderate speed?

Ans. The answer required is the converse of the former one, then $\frac{6.07\times12}{5.2\times7}=2$ inches of water gauge.

Ques. 9. What should be the radial length of the blades of a fan on the first motion, when 5 inches is allowed for every pound of mine resistance, which in this case is equal to 2.2 inches of water gauge?

Ans. $\frac{2.2\times5.2\times5}{12}=4.76$ feet, the length of the blades required.

Ques. 10. What should be the mine resistance for a fan in which the radial length of the blades is 4.76 feet, and 5 inches is allowed in this length for every pound of mine resistance?

Ans. $\frac{4.7666\times12}{5.2\times5}=2.2$ inches of water gauge.

Ques. 11. Two centrifugal ventilating fans on the first motion, are equal in diameter, and are intended to produce equal quantities of air in cubic feet per minute, but the radial length of the blades in A is such that there is an allowance of 7 inches in the radial length, per pound of mine resistance, whereas, in B the allowance is only 5 inches; and taking the speed of A at 1, what should be the speed of B, if A makes 70 revolutions per minute?

Ans. As the pressures vary directly as the radial lengths of the fan blades multiplied by the squares of the velocities, let L be the greatest radial length, and l the least, and let v be the given velocity of A, and V the sought for velocity of B, then $\frac{Lv^2}{l}=V^2$ or $\sqrt{\frac{Lv^2}{l}}=V$ as $\sqrt{\frac{L\times70^2}{l}}=82.825$, the speed of the fan B in revolutions per minute, to produce the same quantity of air in cubic feet per minute as A.

Ques. 12. In two fans, A and B, the radial lengths of the blades and other things are equal, except the diameters and peripheral speeds: Now, if A runs at 80 revolutions per minute and is 24 feet in diameter, what should be the speed of B to produce the same quantity as A, B's diameter being only 20 feet?

Ans. The speeds of A and B must be inversely as their diameters, then if A's speed is 80 revolutions B's speed will be $\frac{24\times80}{20}=96$ revolutions per minute, to obtain the same quantity of air in cubic feet per minute as that of A.

Ques. 13. What should be the area of the port or ports of entry, for a fan exhausting from a mine a quantity of 200,000 cubic feet of air per minute?

Ans. The best results are obtained when the area is found by dividing the quantity by the constant number, 1,300, or $\frac{Q}{1,300}=\frac{200,000}{1,300}=153.8$ square feet, the area of the port or ports of entry required.

Ques. 14. The area of the ports of entry of a fan is equal to 100 square feet, what then should be the maximum quantity produced by it to obtain the best useful effect?

Ans. Q is equal to $1,300\times100$, or let A = the area, and C the constant, then $Q=AC$, as $1,300\times100=130,000$ cubic feet of air per minute, the quantity required.

Ques. 15. A ventilating fan admits air at both sides, and the diameter of each port of entry is 8 feet, what, then, is the joint area of the two ports?

Ans. The joint area of the two ports of entry will be; $8^2\times.7854\times2=8\times8\times.7854\times2=100.5312$ square feet.

Ques. 16. As the throat of the fan should be equal in area, to the joint areas of the ports of entry; what should be the length of the throat, or breadth of the fan blades?

Ans. The length of the conceivable surface of the throat cylinder, or what is the same, the breadth of the fan blades, can be found by dividing the area of the ports of entry by the circumference of the throat, as $\frac{100.5312}{8\times3.1416}=4$ feet, the length of the throat, or breadth of the fan blades required.

Ques. 17. What should be the area of the port or ports of discharge of a fan producing 150,000 cubic feet of air per minute?

Ans. If the quantity required be Q, and the area required be A, and the constant number be C, then $Q=AC$, or $\frac{Q}{C}=A$, as $\frac{150,000}{2,600}=57.69$ square feet, the area of the port of discharge required, being half that of the port of entry, or C for the port of entry being 1,300, C for the area of discharge is 2,600.

Ques. 18. Suppose that the port of discharge for the last question had been 30 instead of 57.69 square feet, what increased velocity would be required by the fan, to maintain the outflow of the same quantity, 150,000; the mine resistance being 10 pounds per square foot?

Ans. Taking the *vena contracta* at .62, the velocity in the former case, in feet per second, would be $\frac{150,000}{57.69\times.62\times60}=69.895$, and this would require a pressure of $\frac{69.895^2\times2,120}{1,800,000}=\frac{4,885.3\times2120}{1,800,000}=5.75$ pounds pressure per square foot, and as the pressures vary as the squares of the velocities, $\left(\frac{57.69}{30}\right)^2\times5.75=21.3$ pounds per square foot, the pressure required for the reduced area.

Now to 21.3, and to 5.75 add the mine resistance 10, as, $21.3+10=31.3$, and $5.75+10=15.75$, and we can at once determine the increased velocity of the fan due to the reduced area of discharge, for the velocities vary as the square roots of the pressures, then the velocity required is, if the former velocity was 1, $\sqrt{\frac{31.3}{15.75}}=1.4$, or, if the revolutions in the first case were 70 per minute, in the latter they would be $1.4\times70=98$ revolutions per minute.

104. Velocities of Air Currents Into Depressions.—Ques. 19. At what velocity will air pass through an orifice into a depression, where the pressure is 5 pounds per square foot below that of the atmosphere.

Ans. As the depression in a fan does not affect this value, we only have the 5 pounds to consider, and as air is elastic, the expression is, $\sqrt{\frac{5\times1,800,000}{(2,120+5)}}=\sqrt{\frac{5\times1,800,000}{2,125}}=65.08$ feet per second, the velocity required.

Ques. 20. What is the velocity and mean quantity of air passing through an orifice of 50 square feet, into a depression of 20 pounds per square foot below the pressure of the atmosphere?

Ans. The velocity per second of elastic air rushing into a depression 20 pounds per square foot below the pressure of the atmosphere will be $\sqrt{\frac{20\times1,800,000}{(2,120+20)}}=\sqrt{\frac{20\times1,800,000}{2,140}}=129.7$ feet, the velocity per second, or $129.7\times60=7,782$ feet per minute. Taking the *vena contracta* at .62 the quantity required will be $7,782\times50\times.62=241,242$ cubic feet of air per minute.

Ques. 21. What should be the area of an orifice for the admission of 180,000 cubic feet of air per minute, when the air is flowing into a depression where the pressure is 7 pounds per square foot below the pressure of the atmosphere?

Ans. The velocity of the inflowing air per second will be equal to $\sqrt{\frac{7\times1,800,000}{(2,120+7)}}=\sqrt{\frac{7\times1,800,000}{2,127}}=76.967$ feet per second, or, $76.967\times60=4,618$ feet per minute and taking the *vena contracta* at .62, the area of the orifice in square feet will be equal to $\frac{180,000}{4,618\times.62}=62.86$.

Ques. 22. The smallest port in an exhausting fan, is that of discharge, and it is equal to 45 square feet. The total pressure due to the motive column is equal to 14.5 pounds per square foot of section:

The mine resistance is equal to 9 pounds per square foot of section. What then is the quantity of air in cubic feet per minute passing out of the fan?

Ans. Here the expression $\sqrt{\frac{(T-M)\times1,800,000}{(2,130+M^2)}}=v$ meets the requirements of the case.

Then $\sqrt{\frac{(14.5-9)\times1,800,000}{(2,130+9^2)}}=v=\sqrt{\frac{5.5\times1,800,000}{2,211}}=67$, nearly, = the velocity of discharge in feet per second, and taking the *vena contracta* at .62 the quantity of air discharged by the fan in cubic feet per minute will be, as, $67\times60\times.62\times45=112,158$ cubic feet.

Ques. 23. The calculated total pressure, due to an exhausting fan, is found to be 18 pounds per square foot of section of the motive column; and the mine resistance is found to be 11 pounds per square foot of section, at the top of the upcast shaft; the smallest orifice is found to be the throat of the fan, that is 52 square feet in area: What, then, is the quantity of air exhausted by this fan in cubic feet per minute?

Ans. We will find the velocity of the air passing through the throat of the fan in feet per second, by the expression $\sqrt{\frac{(T-M)\times1,800,000}{(2,130+M^2)}}=\sqrt{\frac{7\times1,800,000}{2,251}}=74.82$ feet. The quantity per minute will therefore be, if we take the *vena contracta* at .62,

$$74.82\times60\times.62\times52=144,731.6 \text{ cubic feet.}$$

Ques. 24. The calculated total pressure for a blowing fan is found to be 14 pounds per square foot of the motive column, and the mine resistance, as measured with the water gauge is found to be 1.4 inches. The smallest orifice is the port of entry, whose *mean* area is 57 square feet, what, then, is the quantity of air in cubic feet per minute, blown into the mine with this fan?

Ans. The following expression is used to find the velocity of the air in feet per second through the smallest orifice of a blowing fan: $\sqrt{\frac{(T-M)\times1,800,000}{(2,130+M)}}=\sqrt{\frac{(14-7.28)\times1,800,000}{(2,130+7.28)}}=\sqrt{\frac{6.72\times1,800,000}{2,137.28}}=75.23$ feet, and the quantity of air in cubic feet per minute blown into the mine with this fan will therefore be, if the *vena contracta* is taken at .62, as $75.23\times60\times.62\times57=159,517.7$ cubic feet.

Ques. 25. The orifice of discharge has a smaller area than the other ports of a blowing fan, and it is equal to 49 square feet. The quantity the fan blows is equal to 150,000 cubic feet of air per minute, what, then, is the velocity of the air in feet per second out of the orifice, when the *vena contracta* is taken at .62?

Ans. $\frac{150,000}{.62\times49}$ is equal to the velocity per minute, and, therefore, $\frac{150,000}{.62\times49\times60}=82.29$ is equal to the velocity of the air in feet per second out of the orifice of discharge of a blowing fan.

Ques. 26. If the orifice of discharge in a blowing fan is the smallest, and has a mean area of 53 square feet; let the quantity blown be 160,000 thousands of cubic feet of air per minute, and let the mine resistance be equal to 1.8 inches of water gauge: What, then, will be the total pressure under these conditions?

Ans. Let us first find the velocity in feet per second by making the *vena contracta* .62, as, $\frac{160,000}{60\times53\times.62}=81.15$. As the pressures vary as the squares of the velocities, it follows that the pressure blowing the air out of the fan will be proportionate to $\frac{81.15^2\times(2130+9.36)}{1,800,000}=\frac{6,585.3\times2,139.36}{1,800,000}=7.827$ pounds per square foot, and the total pressure that "blows," and overcomes the mine resistance will, therefore, be $7.827+(1.8\times5.2)=7.827+9.36=17.187$ pounds pressure per square foot of the radial motive column.

Ques. 27. The ventilation due to an exhausting fan is equal to 190,000 cubic feet of air per minute; the mine resistance is equal to 1 inch of water gauge; the area of the smallest port, is the orifice of discharge, and it is equal to a mean area of 60 square feet. Now take the *vena contracta* at .62, and find the total pressure due to the centrifugal force produced by the rotation of the fan.

Ans. First find the velocity of the air out of the orifice of discharge, as follows, $\frac{190,000}{60\times.62\times60}=85.12$ feet per second, and as the pressures vary as the squares of the velocities, it follows, that the pressure discharging the air from the fan can be found as follows: $\frac{85.12^2\times(2,130+5.2^2)}{1,800,000}=\frac{7,245.41\times2,157}{1,800,000}=8.68$ = the pounds pressure per square foot required for blowing out; then, $8.68+5.2=13.88$ pounds, is the total pressure per square foot of section due to the centrifugal force produced by the rotation of the fan.

Ques. 28. A centrifugal exhausting fan is 24 feet in diameter; the radial length of the blades is 8 feet. What, then, is the mean velocity of the radial air column when the fan is running at 80 revolutions per minute?

Ans. Practically, the radius of gyration is 8 feet in length; half the length of the blades being 4 feet and the radius of the orifice of entry being 4 feet also, or $4+4=8$ feet. The mean velocity then of the radial column in feet per second, is as follows:

$$\frac{8\times2\times3.1416\times80}{60}=67.02 \text{ feet.}$$

Ques. 29. The diameter of a fan is 30 feet; the radial length of the blades is 8 feet. What, then, is the practical length of the radius of gyration?

Ans. To find the practical length of the radius of gyration, subtract the radial length of the blades from the diameter of the fan, and half the difference is the length of the radius of gyration, as $\frac{(30-8)}{2}=11$ feet, or the length of the radius of gyration.

Ques. 30. The radial length of the blades of a fan is 9 feet, what then is the weight of this motive column of air, that is taken as W in making fan calculations?

Ans. The average weight of a cubic foot of air is .0766, then $W=.0766\times9=.6894$ of a pound.

Ques. 31. Find the value of W in four cases in which the radial columns are 4, 5, 6 and 7 feet in length, respectively?

Ans. $W_1=.0766\times4=.3064$ in first case.
$W_2=.0766\times5=.3830$
$W_3=.0766\times6=.4596$
$W_4=.0766\times7=.5362$.

Ques. 32. An exhausting fan is 24 feet in diameter; the radial length of the blades is 8 feet; the angular velocity is 75 revolutions per minute. What, then, is the velocity of the center of gyration in feet per second?

Ans. The diameter of gyration is $24-8=16$ feet, and, therefore, the velocity required in feet per second is $\frac{16\times3.1416\times75}{60}=62.832$ feet.

Ques. 33. A blowing fan is 20 feet in diameter; the radial length of the blades is 6 feet; the angular velocity is 92 revolutions per minute. What, then, is the velocity of the center of gyration in feet per second?

Ans. The diameter of gyration is $20-6=14$ feet, and, therefore, the velocity of the center of gyration in feet per second, is as follows: $\frac{14\times3.1416\times92}{60}=67.43968$ feet.

Ques. 34. The velocity of the center of gyration of the radial column of air in a fan is 70 feet per second; the length of the blades is 7 feet. What then is the value of the centrifugal force, expressed as pressure per square foot?

Ans. The following equation expresses the value sought for, and is known in these examples as T.

$\frac{v^2W}{3.1416g}=T$, then, $\frac{70\times70\times7\times.0766}{3.1416\times32.16}=26$ pounds; or T, the total pressure, that includes the mine resistance and the depression produced in the fan, is equal to 26 pounds pressure per square foot of the radial motive column.

QUES. 35. What is the speed of the periphery of a fan 24 feet in diameter, when the radial length of the blades is 8 feet, and the center of gyration has a velocity of 65 feet per second?

ANS. First find the diameter of gyration, as 24 − 8 = 16 feet, and as circumferences are in the same proportion to each other as their diameters, it follows that the speed of a point in the periphery of the fan, must be to that of the center of gyration, as 24 is to 16 or $\frac{24}{16} \times 65 = 97.5$ feet per second, or 97.5 × 60 = 5,850 feet per minute, is the speed of a point in the periphery of the fan.

QUES. 36. A ventilating fan is 18 feet in diameter; the radial length of the blades is 5 feet; the angular velocity of the fan is 85 revolutions per minute. What then is the value of the centrifugal force expressed in pounds pressure per square foot of radial motive column.

ANS. The diameter of gyration will be as 18 − 5 = 13 feet, and, therefore, the velocity of the center of gyration in feet per second is equal to $\frac{13 \times 3.1416 \times 85}{60} =$ 57.8578 feet. T will then be equal to $\frac{W v^2}{3.1416 g}$ = T = $\frac{.0766 \times 5 \times 57.8578^2}{3.1416 \times 32.16}$ = 12.69 pounds, the total pressure required.

QUES. 37. An exhausting fan is 25 feet in diameter; the radial length of the blades is 7 feet; the mine resistance is equal to 3.2 inches of water gauge; the angular velocity of the fan is equal to 78 revolutions per minute. What, then, is the velocity in feet per second of the air thrown off by the fan, the orifice of discharge being the smallest?

ANS. The diameter of gyration will be 25 − 7 = 18 feet, and the velocity of the center of gyration in feet per second will be $\frac{18 \times 3.1416 \times 78}{60} =$ 73.514 feet. Now T will be equal to $\frac{v^2 W}{3.1416 g} = \frac{73.514^2 \times 7 \times .0766}{3.1416 \times 32.16} =$ 28.68 pounds. E, the pressure of discharge will then be equal to 28.68 − (3.2 × 5.2) = 28.68 − 16.64 = 12.04 pounds per square foot of section of orifice. Therefore, the velocity of discharge will be equal to $\sqrt{\frac{(T-M) \times 1,800,000}{(2130+M^2)}} = \sqrt{\frac{12.04 \times 1,800,000}{2406.8896}} =$ 94.89 feet per second, the required velocity of discharge.

QUES. 38. An exhausting fan is 26 feet in diameter; the radial length of the blades is 8 feet; the angular velocity is equal to 72 revolutions per minute; the mine resistance is equal to 2.7 inches of water gauge; the orifice of discharge has an area of 52 square feet, and it is the smallest port. What, then, should be the quantity of air in cubic feet per minute thrown off by this fan?

ANS. The diameter of gyration will be equal to 26 − 8 = 18 feet; the velocity of the center of gyration will be equal to, in feet per second, $\frac{18 \times 3.1416 \times 72}{60} =$ 67.8585 feet; T will be equal to $\frac{v^2 W}{3.1416 g} = \frac{67.8585^2 \times 8 \times .0766}{3.1416 \times 32.16} =$ 27.92 pounds pressure per square foot of the area of the orifice of discharge, and the velocity of the outflow will therefore be equal to $\sqrt{\frac{(T-M) \times 1,800,000}{(2,130+M^2)}} = v$ or this will be equal to $\sqrt{\frac{13.88 \times 1,800,000}{2,327.12}} =$ 103.6 feet per second.

The quantity then of air discharged from the fan in cubic feet per minute must be, when the *vena contracta* is taken at .62, equal to 103.6 × 60 × 52 × .62 = 200,403.84 cubic feet.

QUES. 39. A blowing fan is 21 feet in diameter; the radial length of the blades is 6 feet; the angular velocity is equal to 84 revolutions per minute; the mine resistance is equal to 2.4 inches of water gauge, and the orifice of discharge is equal to an area of 40 square feet, and if the *vena contracta* is taken at .62 what quantity of air in cubic feet will this fan blow into the mine per minute?

ANS. The diameter of gyration will be equal to 21 − 6 = 15 feet; the velocity of the center of gyration in feet per second will be equal to $\frac{15 \times 3.1416 \times 84}{60} =$ 65.97 feet, and T will be equal to $\frac{v^2 W}{3.1416 g} = \frac{65.97^2 \times 6 \times .0766}{3.1416 \times 32.16} =$ 19.79 pounds per square foot of area of the orifice of discharge; the velocity of the air discharged will be as $\sqrt{\frac{(T-M) \times 1,800,000}{(2,130+M)}} = \sqrt{\frac{7.31 \times 1,800,000}{2,142.48}} =$ 78.36 feet per second. The quantity will therefore be 78.36 × 60 × 40 × .62 = 116,599.68 cubic feet of air per minute forced into the mine with a blowing fan.

QUES. 40. An exhausting fan is on the second motion and runs with an angular velocity of 140 revolutions per minute; the diameter of this fan is 12 feet; the radial length of the blades is 3 feet, and the port of discharge is the smallest and has an area of 20 square feet, and the mine resistance is equal to 1.1 inches of water gauge: What, then, is the quantity of air in cubic feet per minute exhausted by this fan?

ANS. The diameter of gyration will be equal to 12 − 3 = 9 feet; the velocity of the center of gyration in feet per second will be equal to $\frac{9 \times 3.1416 \times 140}{60} =$ 65.97 feet. T, or the total of the centrifugal force due to the radial column, will be equal to $\frac{65.97^2 \times 3 \times .0766}{3.1416 \times 32.16} =$ 9.898 pounds per square foot of motive column. The velocity of the air discharged will be equal to $\sqrt{\frac{(T-M) \times 1,800,000}{(2,130+M^2)}} = \sqrt{\frac{4.178 \times 1,800,000}{2,162.71}} =$ 58.969 feet per second, and the quantity sought for must, therefore, be equal to 58.969 × 60 × 12 × .62 = 26,323.87 cubic feet of air per minute.

QUES. 41. A blowing fan is on the second motion, and runs with an angular velocity of 200 revolutions per minute; the diameter of the fan is 14 feet, and the radial length of the blades is 3.5 feet; the port of discharge is the smallest, and has an area of 40 square feet; and the mine resistance is equal to 2.5 inches of water gauge. What, then, is the quantity this fan is blowing in cubic feet per minute?

ANS. The diameter of gyration will be 14 − 3.5 = 10.5 feet; the velocity of the center of gyration will be equal to $\frac{10.5 \times 3.1416 \times 200}{60} =$ 109.95 feet per second, and T, the pressure due to the centrifugal force of the radial column will be equal to $\frac{v^2 W}{3.1416 g} = \frac{109.95^2 \times 3.5 \times .0766}{3.1416 \times 32.16} =$ 32.08 pounds per square foot of the area of discharge.

The velocity of the outflowing air will be equal to $\sqrt{\frac{(T-M) \times 1,800,000}{(2,130+M)}} = \sqrt{\frac{19.08 \times 1,800,000}{2,143}} =$ 126.6 feet per second, and we can now determine the value of the required quantity as follows: 126.6 × 60 × 40 × .62 = 188,380.8 cubic feet of air per minute blown into the mine with this fan.

QUES. 42. A centrifugal exhausting fan is 12 feet in diameter; the radial length of the blades is 3 feet; the fan is on the second motion and runs with an angular velocity of 300 revolutions per minute; the mine resistance is equal to 2.6 inches of water gauge; the port of discharge is the smallest, and is 30 square feet in area. What quantity of air will this fan exhaust from the mine, in cubic feet per minute?

ANS. The diameter of gyration will be equal to 12 − 3 = 9 feet; the velocity of the center of gyration will be equal to $\frac{9 \times 3.1416 \times 300}{60} =$ 141.372 feet per second and T, the pressure of the radial column, will be equal to $\frac{v^2 W}{3.1416 g} = \frac{141.372^2 \times 3 \times .0766}{3.1416 \times 32.16} =$ 45.45 pounds per square foot of area. The velocity of the air thrown off by the fan will be equal to $\sqrt{\frac{(T-M) \times 1,800,000}{(2,130+M^2)}} = \sqrt{\frac{31.93 \times 1,800,000}{2,312.79}} =$ 157.64 feet per second, and the quantity will, therefore, be equal to 157.64 × 60 × 30 × .62 = 175,926.25 cubic feet of air per minute.

(*To be Continued.*)

METHODS OF MINING IN BUTTE.

There is no question but that mining, as practiced in the Butte district, is on a most scientific scale and is not surpassed in any part of the world. Mining men and corporations from all parts of the world send their experts here to study and obtain information respecting the development of large ore bodies in an economical manner, and also to inquire into the systems of hoisting, pumping, timbering, etc., as well as the treatment of ores.

The development of the Butte mines has entirely been accomplished by shafts, these being, with probably two exceptions, vertical—the exceptions being the Gagnon and Stewart. The system of shafts are of one, two and three compartments; a large majority of them being two, while the largest mines in the district use the three-compartment. One of these is used for manway and pumps, while the other two are used for hoisting—one cage is lowered and the other raised at the same time. Shafts vary in size from 5x9 feet to 5x20 feet in the clear, and are generally timbered with the ordinary square-sets, and lagged with two and three-inch planks. These timbers vary from 8x8 to 12x12 inches, and are framed on the surface by machinery especially made for this purpose. In the Gagnon mine round-sets are used with good success.

The types of "gallows frames" in vogue are either the vertical—those with two slanting timbers, or those with four uprights, and corresponding braces. The Anaconda and Syndicate and other large mines prefer the latter as being more especially adapted to rapid and heavy hoisting. These average about sixty feet in height.

The hoisting engines vary greatly in size, being from 12x00 to 20x60 inches. The large hoist at the Anaconda is one of the old-fashioned type. The one that has just been erected at the Green Mountain has a pair of 28x72-inch cylinders, and so far is the largest one erected in the district, and is designed to hoist three cars of ore on each of the two triple-decked cages—the first of the kind in the camp. A new hoisting engine is now being built by the Union Iron Works of San Francisco for the original Anaconda, and it is hoped to have the same in operation early next spring. This will greatly exceed that of the Green Mountain as to capacity. Each cage will be operated by two pairs of compound vertical engines and operating beams, which rotate the shaft. Both the high and low pressure cylinders will have a stroke of seventy-two inches; the former being twenty-six inches in diameter and the latter forty-six. The two reels will wind up nearly 5,000 feet of steel cable ⅝x8 inches. The clutches will be of the friction type, which with the brakes and reversing gear, will be operated by steam.

In the incline shafts at the Gagnon and Stewart mines cages or skips are used. When hoisted to the surface they are automatically dumped into the ore bins or cars.

Nearly all the important mines are equipped with air compressing plants, and machine drills are numerous. Several of the leading companies rely to a great extent in prospecting new ground on the Diamond core drill, and the occurrence of this most useful implement is daily becoming more prevalent.

For pumping water from the mines, the Knowles pump is in the lead. There are but very few mines now using the Cornish pump. A large Riedler duplex pump has lately been put in the Silver Bow mine at the 1,000-foot level which is estimated to pump 1,000 gallons of water per minute from this level.—*Western Mining World.*

Wire Rope Transportation.

A new and attractive card of the Trenton Iron Co., which appears in this column is worthy the attention of our readers. This company enjoys an enviable reputation as manufacturers of wire and wire ropes of all kinds, wire rope tramways, cable hoists, and haulage and coal equipments for the transportation of materials.

Mr. Abram S. Hewitt, of national reputation, is President of the company, and Mr. E. Gybbon Spilsbury, an engineer whose name is familiar to every technical man as one of the leading engineers of the world, is Managing Director of the company. The connection of these gentlemen with the company is a guarantee of the quality of the goods turned out.

A couple of years ago we called attention to a blue book on Wire Rope Transportation issued by this company which was sent free to all mine owners and mine managers on application. The book is a very handsomely illustrated volume, bound in cloth and contains first-class illustrated articles on Wire Rope Transportation, Wire Rope Haulage and Wire Rope Transmission. In fact it is one of the best publications extant on these subjects. It is more of a text-book than an advertisement. Any of our readers who did not receive a copy of the last issue of this book will be highly gratified if they send to the Trenton Iron Company, Trenton, N. J., for a copy of the new issue. We have never yet called attention to a book of greater value to mine owners and mine managers. Besides manufacturing the materials, etc., we mention, the Trenton Iron Company make a large number of specialties in wire goods, and the evidence of their superior quality is in the numerous awards allowed them at the Columbian Exposition, at Chicago, where their display was certainly a magnificent one. Among the recent productions of this company is a new grade of heat resisting wire for electric heaters which is meeting with great favor. Other specialties are the Patent Lock Wire Rope, Bleichert Patent Wire Rope Tramways, and a Patent Bale Tie known to the trade as the Anchor Tie.

Some of these specialties are not of special interest to mine managers and mine officials, but the book we mention is, and the description of wire rope tramways, cable hoists and conveyors, and the application of wire rope to mine haulage are of such a nature that the mining engineer or mine manager who does not possess a copy misses a valuable publication from his technical library.

A Louisiana Sulphur Mine.

The Standard Oil Co., has finally solved the problem of winning the curious and valuable sulphur deposit in Calcasieu parish, Louisiana.

For thirty-five years company after company has experimented with this deposit of sulphur, which is probably the largest in the country, and is valued at from $30,000,000 to $100,000,000. There was no doubt about the sulphur being there, but unfortunately between it and the surface lay an immense quicksand, which could not be removed, excavated, or bored through. There seemed to be no way of man reaching the sulphur and getting it up. A small town, Sulphur City, has grown up in the neighborhood of the mines, at which lived the operatives engaged in trying to solve the problem. As the expenses of these employes had to be paid, and as not a pound of sulphur was obtained, the several companies organized to mine it went one after another into bankruptcy, until the property fell, a short time ago, into the hands of the great Standard Oil Company.

Long before the discovery of petroleum in Pennsylvania a party of hunters stumbled on a petroleum spring in Calcasieu. The Louisiana Petroleum Company was organized to bore for it, and while boring discovered that side by side with the oil was one of the most valuable deposits of nearly pure sulphur in the world. The sulphur was 400 feet below the surface and extended below, 800 feet further. There was no doubt or question about this, but, unfortunately, just above the sulphur was a quicksand 160 feet thick. One effort after the other to reach the sulphur failed. After several deaths the American Sulphur Company gave up the enterprise. Then a Belgian engineer undertook the work and endeavored to neutralize the quicksand by freezing it solid and boring it through (Poetsch process) and erected valuable refrigerating machinery for that purpose, but the quicksand would not stay frozen and that system of mining had to be abandoned.

Recently the Standard Oil Company obtained control of the property. It set about mining in a fashion the very opposite to that of the Belgian engineer. Instead of using freezing as the means of getting at the sulphur, it is trying heat. Superheated water is forced through ten-inch cased borehole on the sulphur, melting it. The liquid sulphur water is then pumped up. A little exposure to the air evaporates the water and leaves almost pure sulphur. The experiment has been successful beyond expectations.

MISCELLANEOUS.

PHENOMENA OF THE HAIR.

A fact not generally recognized, and the importance of which is woefully misunderstood by the majority of those who have looked into the matter, is the old truth that the hair is the barometer of a person's health and character.

Before introducing examples it will be necessary to explain the nature and composition of the hair. The hair consists of a root, a shaft, and a tip, the latter two being the projecting parts. Its substance is composed of a horny material containing the pigment granules, which are developed in the root, and the color of which depends on the presence of a peculiar oil—sepia tint in dark, blood red in red, yellowish in fair hair. While it was generally admitted that the hair of all mammalia had nerve connection, a similar state of affairs has been denied with reference to human hair until quite recently. The past lack of knowledge accounts for the skepticism of the modern physiologists above mentioned. Their argument was logical: If nerve activity did not reach the hair root, it could not affect it.

Let us settle one more point, the cause of gray hair in advanced life. The grayness commences at the hair bulb, where the cells are produced, and rises upward to the tip. It is caused by a deficiency and the degeneration respectively of the pigment matter. The coloring stuff either gives out or retrogrades. The chemist can perform the same for you in an incredibly short time by simply soaking your raven or auburn locks removed from the head in alcohol or ether.

Dr. Landois of the Greifswald Clinic had a patient suffering from delirium tremens, who saw rats and other animals constantly running about him. He was extremely nervous, and when, on the fourth night after his arrival in the institute, one of the physicians entered the ward suddenly, he became so terrified that he wrapped himself up in his blanket, while his teeth chattered and his limbs trembled. Next morning the patients and medical attendants observed a great change in the appearance of the man. Three-fourths of his hair and beard had become gray. The celebrated Dr. Virchow, among other authorities, investigated the case, and gave it as his opinion that degeneration of the pigment matter had nothing to do with the change.

The French physician, Raymond, had a female patient suffering from neuralgia. The lady's hair was jet black. After an especially bad attack of pain the hair took on a reddish hue, and after some hours faded into gray. The change occurred within a space of five hours.

Several medical reports set forth that patients suffering from disease of the nerves in the head became gray at the very spots where pains manifested themselves. This change, in the majority of cases, took place slowly; in some cases it occurred over night.

A young man, 18 years old, serving in the German army as an aspirant for a Lieutenantship, had been discovered in the act of hazard playing by his chief. He feared to be dishonorably dismissed from his regiment and spent twenty days in dreadful anticipations. When finally his case was passed on by his Colonel, that gentleman decided not to punish the young fellow on condition that he promised never to touch a card. After it was all over I cut a bunch of hair from the culprit's head to subject it to a microscopical investigation.

In this connection it should be stated that the growth of hair allows of measurement day by day. At an average young people's hair grows at the rate of fifteen lines (twelve lines make one inch) per month, but there are exceptions. My young friend's hair, according to previous investigations, grew only at the rate of one-fourth of a line per day. Taking this for the basis of my examination, it was easy to determine on what particular days certain portions of the hair I cut from his head had formed. I found that, beginning with the particles formed on July 5, and terminating with the formations of July 24, the hair had changed from brown to reddish and light bluish tints, increasing in intensity until under the microscope it appeared almost a yellowish white.

Recourse to the young fellow's diary showed that during that period he had gambled, losing steadily. Consequently his nervous excitement grew apace. On the 24th it reached its height, when the rascal found himself vis-a-vis of Nemesis personified by his superior officer. After that followed a period of quiet resignation, during which time the hair formations assumed their natural color, but as the day of judgment drew near, in the second week of August, the tint changed again from brown to brown yellow and bluish green. The inference is obvious.

A gentleman of my acquaintance received on October 16 last year news that his only son was suffering with a fatal malady. On November 4 the patient was declared to be out of danger. Five days later I cut a bunch of hair from my friend's head, and, after conducting preliminary investigations similar to those in the case of the young soldier, I let the microscope tell the story. The formations from the roots upward covering a period of five days, were entirely normal; those formed between October 16 and November 4 exhibited the following tints:

Black blue turned red, red turned yellowish brown, yellowish brown, blood orange, blood orange a light yellow.

I also discovered another phenomenon in connection with this case, as well as with others that have come under my observation. The particle of hair grown on the day when the individual experienced a sudden shock—at the news of a son's fatal illness, for instance—seemed to be bent, so as to occasion a flaw in it, and at the concave part of that impression I found a number of infinitesimal corpuscles, apparently parts of the hair root. That shows the tremendous force which the nerves and muscles exercise over the hair, a symptom, by the way, which the average individual finds exemplified in the sensation commonly called "goose flesh" or goose skin. It is endured as a consequence of sudden fright or terror. The skin of the head for the moment loses its smoothness, the hair roots elevate, the hair itself becomes rigid, the color of the skin is pale. Medical science explains this phenomena as follows: The hair contains certain muscular fibre cells, which arise in the upper part of the corium. As each hair enters the skin obliquely, forming an acute angle with the surface, and as the muscle lies in the corresponding obtuse angle, its contraction erects the hair, that is, makes it stand up.

The microscope does not explain the last-mentioned phenomena; it shows, however, the nature of the causes that make the hair appear white as the consequence of fear, distress or any strong mental excitement. As already stated, the sensation is apparently due to degeneration of the pigment matter. According to my own investigations it is occasioned by air bubbles arising in the shaft of the hair, and completely enveloping the color particles. How this process comes about science has not yet discovered. It is an open question whether the air is admitted from outside or whether the elastic fluid is the result of decomposition in the interior of the hair shaft or roots.

Another explanation may be mentioned here which says the process may result from the throwing off of some fluid or acid that chemically destroys the coloring matter.

Though our knowledge of the barometer qualities of the hair is yet crude and unfinished, its practical application, even at this early state of medical inquiry, promises advantageous results, for it furnishes not only direct proofs of the existence of mental and physical infirmities, but also, indirectly, denotes a person's healthy condition.—*Condensed from St. Louis Globe-Democrat.*

ELEPHANT WORKERS IN RANGOON.

We had seen many elephants during our Indian journey, and in a variety of occupations, from the temple elephants engaged in their solemn and sleepy processions to the huge and well-groomed animals belonging to the artillery batteries at Quetta and Peshawur on the Afghan frontier, and we had listened to not a few tales of what they could do, sometimes with just a shade of incredulity.

There are about a dozen elephants employed in the work of the yard, and all of these but one are males. This may and probably does, arise from the fact that the males are usually larger and stronger than the female elephants, but, judging from the specimen we saw, it cannot be from any superiority of intelligence on the part of the male animal. The solitary female worker, indeed, is a veritable maid-of-all-work about the yard, and no kind of work appears to come amiss to her. At one time she may be seen holding a log up to the saw when at work, either endwise or across, as occasion may require; at another she is dragging the slabs away with the end of her trunk, and piling them in heaps with all the regularity and skill of the most neat-handed workman; at a third she is making a stack of the sawn boards, or sweeping the sawdust from the mill-house floor with a gigantic broom. The meaning of the whistle to knock off work is not better known to any workman on the place than to her, and it is no easy matter to induce her to do a single trunk's turn when the signal has once sounded.

The log, once piloted to shore, will, at the word of command if not of a greater weight than about a ton and a half, be prized up by the animal's tusk, and then grasped with the trunk carefully and exactly in the middle, and carried to the spot where it is wanted. Arrived at the heap of logs in the yard, he will place one end on the ground and the other on the heap, and then proceed with the most systematic care to push it up and adjust it with the point of his tusks.

You cannot overload an elephant, however, for the animal will at once refuse any load which he considers beyond his strength, and there is practically no appeal from the elephant's opinion on such a question. In case of a log being brought ashore which seems to be too large and heavy for a single elephant, a second is called to his assistance, and the two animals proceed quietly to pick it up by the extreme ends and carry it to the required heap, where they deposit it with the utmost care, even examining it critically to see that it is perfectly in line with the rest of the stack. For this and all other nice processes of adjustment the point of the trunk is the instrument used.

It has been said that an elephant can do everything but speak; and, indeed, we were often disposed to doubt whether there was even this exception. Whatever emotion one of these animals feels he seems ready to express in sound, and so various are the modulations of his voice and so ready their sympathy and apparent comprehension of one another, that we could hardly doubt that the impression that elephants cannot speak was due rather to our ignorance than to their want of the power of making themselves understood. The elephant is very liable to sunstroke, especially when working in the water, and even on shore he is generally furnished with a cover for his head during the hours of the greatest heat. A good elephant is of such value that his health is not to be risked lightly, and, indeed, after we had seen what they could do, we were inclined to go further, and say that a well-trained elephant is absolutely invaluable for heavy labor in a climate such as that in which he finds his natural home.—*From Harpers Weekly.*

TREATMENT FOR ELECTRIC SHOCK.

Some time since, the Paris Academy of Medicine were commissioned by the Minister of Public Works to find if possible some method for saving the lives of persons affected by electric shock.

The professional gentlemen were especially demanded to recommend a method that was at once simple and capable of execution at a moment's notice and by any intelligent person on hand. The Academy selected a committee of electrical experts to report on the case, and the committee began its labors under the Presidency of Dr. A. D'Arsonval, well known on the other side of the ocean as an authority in all matters connected with electricity.

After a careful investigation the committee made a report. In it Dr. D'Arsonval first explains that electricity occasions death of two different sorts: (1) By the disruptive and electrolytic efforts of the discharge, causing injury or destruction of the tissues. This death is final. (2) By arrest of respiration and syncope caused by excitement of the nerve centres. In the latter case there are no material injuries, and death is merely apparent. In both cases the shock may be of the nature termed "heavy." "Heavy shocks" have heretofore been generally considered "sure death," on the supposition that the current produces a contraction of the arteries through its influence on the nervous system, and that this causes an overpowering impediment to the flow of the blood which the heart is unable to overcome. But this is true only if the victim is left unaided for a considerable time, or if his would-be rescuers cease their efforts at too early a period.

"The writer," continues Dr. D'Arsonval, "has always maintained that even the victims of very heavy shocks—as long as the tissues are not destroyed—may be resuscitated by means of artificial respiration. I learned this fact by numerous experiments, and the report of a typical accident in which my method was successfully tried confirmed all I ever entertained for it."

He then quotes instances in which in one case a man was accidently subjected to a current of 4,500 volts for six or seven minutes and was resuscitated, and in another case to 3,000 volts and by the application of the methods recommended his life was saved. The following are the recommendations of Dr. D'Arsonval and the commission:

"My formula for reviving the victims of electric shock is this: A person so disabled should be treated like one drowned. These are the directive rules, which not only workmen in electrical industries but every citizen and every friend of humanity should know by heart:

"Above all, break the contact with the conductors. If the current can be instantly cut off, so much the better. If not, lose no time by telephoning or sending, but apply yourself directly to the body that must be removed.

"In doing so touch not the victim on face or hands, or any naked part of his body. You may try to lift him up by the coat-tails, or after throwing a blanket or coat around him. Mind, they must be dry. Also remember that dry wood is a non-conductor. You may use a stick to draw the body over to one side, or to hold back a live wire. To lift the victim off a cross-bar pass a piece of lumber under his heels and raise him up. The same should be done if the body is in contact with the ground. His feet should be raised from the earth immediately. Any piece of wood, or furniture, or cloth will do.

"The body should be carried into the open or a room where air has free access. All not directly engaged in the work of rescue should be instantly dismissed from the place. The body must be placed upon the back after the shirt and collar have been loosened. Raise the shoulders and let the head fall back.

"Then begin the work of restoring respiration; that is, seize both arms and draw them energetically over the head, bringing them nearly together and holding them in that position for a couple of seconds. These movements having expanded the chest and pressed air into the lungs, carry the arms down to the sides and front of the chest, doubling them up at the elbows, in order to expel the air from the lungs. Continue in this for at least an hour, unless respiration sets in before.

"A second samaritan should at the same time seize the tongue of the victim—it is well to protect one's finger with a piece of cloth or glove for this process—and draw it out while the arms are extended over the head, allowing it to recede when the arms are pressed against the sides of the breast. Both these manœuvres should be carried on with as little interruption as possible. Twenty times per minute is not too much.

"If the victim shows a tendency to clinch his teeth, keep them apart by placing a piece of wood or anything handy between them.

"It is also advised to rub the body with brushes, brooms and cloth, in order to promote the circulation of the blood.

"Do not administer stimulants unless a medical person pronounces it safe to do so. When possible procure a tank of oxygen gas from the nearest drug store, and after improvising a cone, place the tube over the mouth and nose while the gas is issuing. It is a powerful stimulant to the heart's action under certain conditions, and will aid respiration."

AMERICAN COMFORT AND LUXURY.

New York still leads the vulgar race with the most costly art-gallery bar-room, but the other cities boast what their saloon *habitues* would call "close seconds." Buffalo has such a palace, and whereas New York has long had a bar-room with silver dollars let into the floor, Chicago led with the idea, and has five times as many dollars in the floor of the greatest and finest barber shop in Christendom. And Denver prides itself upon a saloon whose floor is studded with twenty-dollar gold coins.

There is no candy and soda water shop in America to equal one in Chicago, whose walls are coated with looking glass cut to gleam like jewels. We pride ourselves upon our railway depot, but Philadelphia has two fine ones—the Pennsylvania and the Reading—and St. Louis' Union depot and the Illinois Central Railway depot in Chicago are splendid stations. San Francisco has swimming baths that no other city parallels, and that city and New Orleans and Galveston have refreshing water-side resorts within their boundaries the like of which the people of other cities are put to trouble, expense, and travel to get at. Chicago has a jewelry store second only to Tiffany's, and approached in only two other American cities—Cleveland and San Francisco. St. Louis has two jewelry stores nearly as fine. The most ambitious shop for the sale of bric-a-brac, outside of New York, is in Cleveland, and no city on the continent has such a book store as McClurg's in Chicago. Pittsburg has one of the finest and most modern theatres in the world, wherein the actors are cared for as they are nowhere else while at work. The best theatres of Chicago are of the first class, and St. Paul, Milwaukee, Cleveland and Denver have each at least one theatre that is finer than some noted ones on Broadway.

Many cities now display tall buildings, but the only dizzy ones—"sky scrapers," as the firemen call them—are in the only two cities in which there are need and excuse for them. Those cities are New York and Chicago, in both of which, for different reasons, the business districts are cramped. As for the club houses of the country, there are none of the conventional types here or in London that are of a higher grade than three in Chicago—the Chicago, the Chicago Athletic and the Union League. There are few clubs in cities of the same size of the East that have better headquarters than the Detroit, Minneapolis, Pacific Union and Bohemian of San Francisco, and the Boston club of New Orleans. The Jewish club of Cleveland should go in the same category. The *Garten Verein*, or Garden club, of Galveston, is a unique institution, delightful beyond any form or variation of the country club in America. The modern plan of putting the kitchens in the tops of buildings has been adopted in certain clubs and hotels in many cities, even of the size of Milwaukee and still smaller Duluth. In their concessions to the women and their quarters for them the Western clubs are far more progressive than most of ours in the East. A large, costly, and attractive "arcade," or interior court of shops, in the business centre of Cleveland, is said to be the finest except one that is in southern Europe. The public parks which Chicago already possesses, and those that are in various stages of development in St. Louis, Milwaukee, Minneapolis and San Francisco, are among the noblest works of our people. Noble splendid residence streets are among the possessions of Cleveland, Minneapolis, St. Louis, San Francisco, Detroit and New Orleans. The finest ones of the semi-parkway type are in Buffalo, St. Paul and Milwaukee.—*From Harper's Weekly.*

WARM FEET.

You will never be in good health and never do your best work if your feet are constantly cold. Grave diseases of the throat and lungs are caused by cold feet alone, and these troubles are always aggravated by a frigid condition of the lower extremities. If proper footwear does not give relief, consult a physician, for the chances are the system is "run down" and radical measures are necessary. In nine cases out of ten, however, the foot covering is to blame, either because of its shape or its material. Save in warm weather, and for low-cut shoes, leather, as ordinarily prepared, has serious objections. It lacks two prime qualities—porosity and capacity for absorption—being in this respect too much like rubber. No foot can remain either comfortable or healthy if kept in a perpetual bath of its own emanations and excretions. Leather, especially that of the more porous varieties, may be tolerated for the outside, but for cold weather it should always be lined with woolen cloth, or, better, with wool felt. In fact, for all cold climates, and for winter wear in all climates where there is any winter, a footgear made from all-wool felt approaches the ideal. According to modern notions, any illness in one part of the body may be occasioned by some irritating cause far removed from the seat of the trouble. Just how this is cannot always be clearly explained, but that such connection does sometimes exist is beyond dispute. In the matter under discussion, if the nerves of the whole body are irritated by a tight shoe, or the extreme coldness of the extremities makes extra demand upon the blood supply, there is neither nerve force nor blood enough left for other functions.—*From the Vocalist.*

LAUNDERED AIR.

A plan for cleaning the air to be used for ventilating purposes, which furnishes to the offices absolutely pure instead of the usual dust, soot and germ laden air of crowded cities, has been put in operation at the offices of the Chicago Telephone Company.

This system, so far as known, is not in operation elsewhere in this country, and its remarkable success is attracting much attention from architects and manufacturers. It has suggested an innovation in the construction of the big office buildings which may lead to a revolution in heating and ventilating systems.

In its workings the system, which has been recently perfected by A. V. Abbott, Chief Engineer of the Chicago Telephone Company, resembles nothing more closely than a laundry. The air breathed by the little army of young women on the top floor of the building is first washed, then dried, then heated or cooled, as the case demands, and finally, to carry out the comparison, it is pressed. The washing removes a wagon load of soot and dust and disease germs, the mere sight of which is enough to arouse wonder in the average man's mind how he lives in the climate of Chicago.

The drying removes every trace of moisture, the heating or cooling brings the air to just the right temperature, and the compression follows as a natural consequence of the introduction of several thousand cubic feet of air every minute into a big room almost hermetically sealed.

It was to overcome conditions which seriously impaired the efficiency of the telephone company's service that the present system of ventilation was devised. The delicate apparatus of the huge switchboard was in a constant state of disorder, owing to the dust and soot that entered the room. Subscribers were continually complaining that their telephones were out of order, as many as 400 complaints being on file in General Manager Hibbard's office at once.

The trouble was not in the telephones, but in the operating room. In this room, 40 by 90 feet, is a switchboard in which are 100,000 little holes, each hole representing four wires. When a subscriber asks for a connection with some other subscriber, the operator pushes a brass plug into one of the holes, which raises a delicate spring known as a "jack." The presence of a speck of dust or soot on one of these "jacks" renders a connection impossible, and then the subscriber complains.

Pure, fresh air, always of the same temperature, now makes the operating room about the most desirable place to work in Chicago. Down in the basement of the building is a big rotary fan that sucks in the air which the ordinary citizen is obliged to breathe. As the current enters the basement through a huge tube it passes into a tightly closed chamber in which a rainstorm is constantly raging. This condition is effected by three rows of small nozzles or atomizers, which discharge a perfect cloud of spray and remove every particle of dirt from the air. The dirt passes off into a well, while the air is whirled through a battery of spiral tubes. The twisting motion of centrifugal force removes the last trace of moisture from the air, and it then passes into another chamber, where it is heated in the winter or cooled with ice in the summer. Then the current is directed upward through a shaft that leads to the top floor of the building and into the operating room.

Every window in the operating room is tightly closed and sealed around the edges, while double doors make it necessary for one to enter the room through what constitutes an air-locked passage. The supply is forced through vents, or registers, opening through the ceiling from a tube that runs around the room. It is compressed air, although its density is so slight as to be almost inappreciable. Every three minutes the air is completely changed, the supply being calculated at 10,000 cubic feet a minute. It leaves the room through outlets fixed in each window, that are provided with delicately adjusted valves opening outward. These outlet tubes take in the air from near the floor, the current being strong enough to draw a piece of paper through the tube and throw it outside. As the valves open outward, there is no chance for the introduction of foul air from the street.

A self-recording thermometer in the operating room tells the story of the success of the system in unmistakable language. Yesterday the instrument showed an almost perfect circle the record of a month's temperature. One or two little jogs in the red tracing showed a variation, at no time exceeding two degrees, a record equal to that of the most carefully regulated hospital. This perfection is attained by a thermostat arranged to keep the air at an even temperature. During the heated season last September, when the mercury was marking 95 degrees every day, the use of five tons of ice daily in the basement of the building reduced the temperature of the operating room to 75 and 80 degrees. Mr. Hibbins estimates that the monthly expense of operating the system is not over $100.—*Chicago Times-Herald.*

THE SEASON OF SHOOTING STARS.

The months of August and November are those in which the so-called shooting stars are most abundant; but they may be seen any night in the year, when the sky is clear, darting out of space across the heavens and vanishing almost before the eye can catch a glimpse of them. It is during August and November that the earth in its course passes through the pathway of the principal meteor streams; but the aerolites are always falling onto the earth, and it is estimated that 400 millions of these fragments are hurled at our globe every 24 hours. Occasionally, these come down in large masses, and there is at the Natural History Museum at South Kensington a mass of meteoric iron weighing 1,400 lbs. It is, however, only a portion of a much larger mass that fell in South America, while on the Continent much greater masses have been found and preserved. But no record exists of anyone having ever been injured by these falling bodies, a fact which is remarkable, considering the size and density of many of them. The reason why the meteorites do no injury to the earth is that the atmosphere by which this globe is surrounded protects us. This may appear strange; but it is not so remarkable. If the heaviest shot we could fire with the most powerful projectile yet made were fired into the ocean, the animals living at the bottom would be completely uninjured by it, for the reason that the mass of water would break the force of the projectile. What the water is to the animal inhabiting the ocean bed the surrounding atmosphere is to the people on the earth. The rush of the aerolites through the atmosphere at a velocity of from 30 to 40 miles per second causes a friction that sets them ablaze, and they are reduced to powder. All over the world this powder is spread, in the deepest valleys, on the loftiest mountains, in the bottom of the sea, and on the plains. It is but rarely that fragments of any size reach the earth; but were it not for our atmosphere, life on this globe would be impossible, owing to the ceaseless shower of stone and iron which is ever being poured upon us from space.

What are called shooting stars, as all with the most elementary knowledge of astronomy are aware, are no more stars than are the Aurora Borealis. Each star is itself a sun, the smallest being in all probability much larger than our own sun, and a million times bigger than the globe we inhabit. So far distant from us are these remote worlds, that if the nearest of them left its orbit and began to rush across the sky to-morrow, we should not see it start for several years to come, and it would take millions of years, traveling all the while thousands of times more rapidly than a cannon shot, to reach the earth. The objects that flash across the heavens are merely solid fragments of stone and iron, revolving in swarms around the sun in well defined orbits at from 30 to 40 miles per second. In olden times it was natural enough for people to speak of them as shooting stars; but there is no longer any excuse for the misnomer. There is one large meteoric stream which takes 33 years to travel round the sun in a kind of egg-shaped orbit, the sun, or focus, being situated near one extremity of the egg. The stream is upwards of 200,000 miles broad, and although traveling at the velocity previously mentioned, it requires fourteen months for it to pass any given point. It was in 1866 that the earth last passed through this rich meteoric region, and on that occasion one observer at Greenwich counted no less than 8,000 of these transient visitants. In four years time, the earth will again pass through the course of this mighty army of meteors, and on the 13th and 14th of November, 1899, we shall be right in the thick of the stream. If it is night time with us when the earth dives into it, meteors by tens of thousands will be visible during the five hours passage. But if it be daylight with us, it will be night in other portions of the world, and there are certain to be multitudes in all quarters of the globe on the look-out for the brilliant spectacle. If these aerolites were really "shooting stars," and fell upon this earth, any one of them would completely overlap this globe and crush down the mightiest buildings raised by the hand of man, break to powder the towering mountains, and by the sheer force of impact fuse the whole into a molten mass. It is quite bad enough to have large masses of iron hurled at us from space; cut if the stars left their courses and fell upon us, the first that reached this planet would annihilate the world.—*Newcastle, Eng., Chronicle.*

CHANGE OF SCENE AT HOME.

A change of air and scene is often prescribed for invalids. In many cases it is a wise prescription, but in others the journey entails expense which cannot be borne without great sacrifice, and means for the sufferer an unhappy isolation among strangers, and a deprivation of the home comforts and care which are so necessary to a sick person's peace and well-being. Homesick and disheartened, the invalid returns from his sojourn among strange scenes not benefitted by the change, and alas! his return is too often but a coming home to die.

Happily it is possible to secure many of the advantages of a change without incurring the disadvantages just described. In other words, a real change may often be secured without sending the patient away from home.

For one thing, his room may be changed to the most cheery and sunshiny in the house. And here, with a little attention an almost daily sunbath may be obtained, a sunbath quite as good as would be afforded at the fine sanitariums in foreign lands or in this country.

Well wrapped from cold and draughts, the patient can sit on the lawn or the piazza, or in the open field or pasture, and breathe the life-giving air. Walks and rides, which need only to be planned for, will aid in the good work. Open windows and open doors, with a fire when needed, will in many instances afford a most salubrious change of air after the close, stuffy rooms in which sick people are prone to spend their time.

A friend,—perhaps a former schoolmate,—where a nurse is out of the question, may be glad to pay the invalid a visit, making himself a cheerful companion, always ready to amuse, to read aloud, to play games, and in general to keep away the "blues."

These few hints will suggest some of the changes that can be wrought at home to aid in restoring the invalid to health, changes which may be effected at small cost of money or convenience.

And after all, if the sufferer fails to find the health hoped for, it is at least a comfort that his last days should be spent at home, sheltered by love and care, and not among strangers, homesick and wretched.—*Youths' Companion.*

THE MARVELLOUS NEW LIGHT.

Great progress has already been made with Prof. Rontgen's wonderful discovery of a new light, if that be a proper description of it, which penetrates many solids, among them aluminum, as if they were glass. Prof. Klupathy of the Pesth University has obtained even greater success in photographing concealed objects. He also varied the experiments by enclosing objects to be photographed in a variety of coverings. It has been ascertained that the light from Crooke's tube penetrates not only organic matter, but also one metal, aluminum. Prof. Rontgen has sent rays of the new chemical light through aluminum plates an inch thick, and they went as clean through as if the substance had been glass. The same was the case with two sets of books, including many volumes; these he placed between a Crooke's tube and an ordinary compass. Behind them was a wooden case with dry plate, and the result was as complete a photograph of the compass as is possible.

All the professor's experiments have been successfully repeated in London this week, and many of them were shown at the meeting of the Camera Club on Thursday. It proves that the strange medium which produces images of hidden objects on a photograph plate is not light at all. It is equally incorrect to describe it as electricity. It is some force or influence produced by Crooke's tube when excited in a peculiar manner, but it is not the visible light or glow which comes from the tube. That visible light has the same qualities as an ordinary light. The invisible new medium has not the same qualities. For instance, it will not penetrate clear glass. It will penetrate ground glass, though more feebly than wood and other organic matter. Aluminum is far more transparent than glass. Even copper is less opaque than glass.

Mr. Swinton, the well-known electrical engineer, showed a large collection of these strange photographs which had been taken to the Camera Club. He employed a half horse power electric current, and passing it through an induction coil, loaded ten Leyden jars. The discharge from them was passed through a second induction coil by a secondary system by which Crooke's tube was excited. He said that he had only succeeded in this way, and had failed with Crooke's tubes excited by an ordinary induction coil.

He showed pictures of the skeleton of a living human hand, a purse containing coins in which only the coins and the metal clasp of the purse were reproduced, and other objects.

The method of procedure was simply to place the object to be photographed between Crooke's tube and the usual wooden case containing the sensitive plate in which the negative is placed when carried to and from the camera. The slide is not removed, and an exposure of from four to twenty minutes is required.

It is perhaps no photograph in the ordinary sense, because no lenses are used. It is not a negative, but a positive plate that is obtained.—*N. Y. Sun.*

LIGHT AND DISEASE.

Two objections are commonly brought against the disinfectants recommended for general use; they are expensive and cannot be used promiscuously without more or less damage. It will be welcome news, therefore, that investigations are now going on, looking to some practical application of the well-known disinfecting properties of light.

Various species of microbes have been examined to ascertain their power of resistance to the sun's rays. For instance Koch has shown that the germ of consumption can withstand the solar rays for only a short time. Cholera germs are easily rendered inert under the influence of direct sunlight, and other germs are susceptible, in varying degrees, to the same influence.

Experiments have been made upon fabrics and manufactured articles of household use, like furniture, by first impregnating them with germs and afterward exposing them to the direct action of the sunlight. It is found that while the sun's rays have a distinct action upon the upper layers of stuff, the disinfecting process is somewhat retarded in the lower or deeper layers. Objects of a dark color are but little affected.

Investigators report that direct solar light kills in from one to two hours any germs of typhoid fever which may be present in water. Even diffused light exerts an appreciable effect in purifying water. In fairly clear water the effect has been known to be exerted at a depth of more than six feet.

In bodies of water exposed to the rays of the sun a minimum of germs is found in the early evening and night hours, and as might have been expected, a maximum of the same germs is found in the early part of the day.

A study of the action of artificial light upon disease has revealed the fact that nearly every germ develops in some one or two particular rays of the spectrum. For instance, typhoid germs multiply rapidly in orange, deep red, or deep violet rays, while they cease to develop in green, blue, or pale violet rays.

This corresponds in some degree to facts elicited by a study of the action of artificial light upon plant-life in general, of which latter facts growers have taken advantage to produce wonderful results.

Of all forms of artificial light the arc-electric seems to promise greatest results to experimenters on this interesting subject, but it is probable that nothing can equal the direct rays of the sun itself.

That the sun does exert an important influence as a disinfectant—and this not merely because of its warmth or drying power—is not to be disputed.—*Youth's Companion.*

ELECTRICITY FOR HIGH-SPEED RAILROAD TRAINS.

If we wish to obtain higher speeds on railroads we must employ more power in proportion to weight than we now have at our disposal with the modern steam-driven locomotive. In order to greatly increase the power, it is necessary that the source of energy should be stationary and the energy transmitted to the moving train, and the only practical way of accomplishing this on a large scale is by employing electricity. An electric engine may be made to develop almost any amount of power, and still be well within the weight and bulk of an ordinary locomotive. In regard to the question of supplying a long road with a powerful high-tension current, I would say that when trains are propelled by steam it is necessary to employ a large number of separate steam engines. Why, then, should there be any objection to using a large number of steam for an electrical railroad? It certainly costs no more to run a stationary engine than a locomotive engine, and the engines for supplying the current could be placed at regular intervals along the line. The tension of the current might be, say, from 2,000 to 5,000 volts. The main conductors should be thoroughly insulated and protected from atmospheric influences. The actual rubbing surface, transmitting the current to the moving train, should be in relatively short sections, and connected to the main conductor only while the train is actually passing, the latter being provided with suitable apparatus for switching the current in ahead of the train and cutting it out after the train had passed. In this manner there would be very little loss of current, even if at a very high tension, and nearly all danger of accidents would be avoided.

With the present steam engines it is necessary to use the very best quality of coal, costing at least twice as much per ton as the cheap coal. A locomotive steam engine has, of necessity, to be a high-pressure, non-condensing engine, and the exhaust steam has to be discharged against considerably more than an atmosphere of pressure, because it has to be employed for inducing the draught. Moreover, for reasons before stated, a locomotive engine must be limited in size.

A stationary engine, however, may be made of any size. It may be a compound condensing, or a triple expansion engine. Large boilers may be employed, having a very large heating surface in proportion to the coal consumed; and the grate surface may be of any size, so that a very cheap coal may be employed. In this manner the cost of developing a given horse-power costs 60 per cent. less than it does on the locomotive.—*Hiram S. Maxim in Cassier's Magazine for January.*

TO RIDE IN A CROWDED CAR.

The following instructions in regard to how to stand successfully in a crowded street car were given in *The American Jewess* for the benefit of women, but from the gymnastic exhibitions we often see given by people of all ages and sexes they should be interesting to all. They are:

Always face the sides of the car, never the front or rear. When the car starts, lean slightly in direction in which it is going. When the car is about to stop lean toward the rear. Plant your feet as far apart as you comfortably can. When a car turns a corner incline the body toward the inside curve of the rails, and when feasible grasp the strap on the side of the car over this inside curve, thus reducing the strain to a minimum. Non-observance of this particular rule is the cause of the frantic clutches and involuntary displays of affection which the standers sometimes bestow upon those seated.

The philosophy of such rules is as follows: You lean toward the direction of the starting car, so that your body, which does not acquire the forward motion simultaneously with the car, shall, so to speak, not be left behind. The starting of the car restores the body to its usual erect posture. You lean toward the rear when the car stops to counteract the forward momentum acquired by the body while the car was in motion. In rounding a curve you lean toward the inside rail to counteract the centrifugal force which tends to throw objects from the centre. But the main thing for you to remember is: Always face the sides of the car. These rules are particularly applicable to cable cars, which rarely fail to start or stop with a jerk.

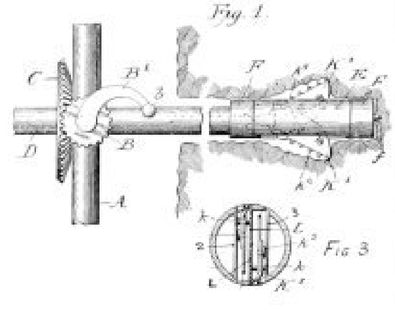
When alighting from the car place the left hand on the brass rod provided for the purpose (I assume that you alight on the railless side) and face the front of the car. Even if the car is still in motion, you are then safe. As for boarding moving cars, I should advise you to wait until your garb is better adapted for higher gymnastics.

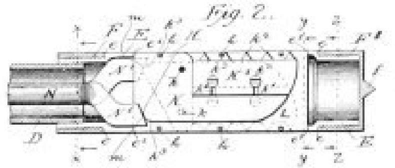
In case these rules prove beneficial the women may thank me. Should they be deficient, why, there's the man.

NEW INVENTIONS.

MINING REAMER.

No. 549,771. R. H. ELLIOTT AND J. B. CARRINGTON, BIRMINGHAM, ALA. *Patented Nov. 12th, 1895.* Fig. 1 shows the reamer in operation, enlarging a drilled hole, to make a pocket for powder. Fig. 2 is a section through the reamer, drawn on a larger scale; and Fig. 3 is a cross-section of the same on the line *y, y.* The body of the tool is made in halves which are held together at the ends by the cap F^1 and the band *E.* The end cap is provided with a conical point, on which the reamer turns when in use. The middle partition plate *L*, is firmly

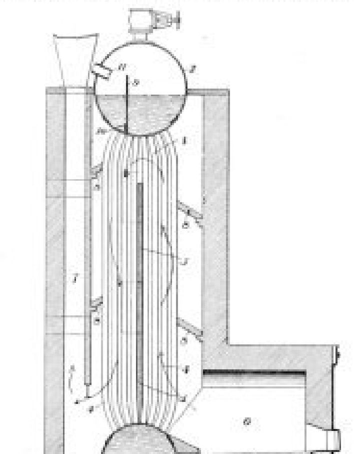




secured to both halves of the shell, and smaller plates 2 and 3, are fastened on each side of it. These plates provide bearings for the fulcrum pins *k*, upon which the cutters are hinged. Each cutter is provided with a removable toothed plate K^1 which can be adjusted by means of the screws k^2. A central rod *N*, having forked ends N^1, is used for driving the cutters outward. The ends N^1, bear upon the heels of the cutters at *a* and compel them to move outward equally. The tool is mounted and operated like an ordinary boring machine, as shown in Fig. 1.

STEAM BOILER.

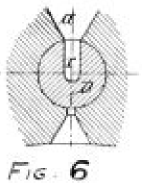
No. 548,455. JAMES PIERPOINT, PITTSBURGH, PENN'A. *Patented Oct. 22nd, 1895.* In the drawing, 2 represents the upper steam and water drum, 3 the mud-drum, and 4 the set of tubes connecting the same. Between the central rows is placed the fire-brick partition 5, which extends from the mud-drum upwardly to a point near the steam drum. 6 is the furnace, from whence the gases pass upwardly among the front rows of tubes, then descend among the rear rows, and thence ascend through the outlet flue 7. Deflecting plates 8 are employed to hold the gases in contact with the tubes, thus insuring the abstraction of heat thereby. In the steam and water drum there is a baffle-plate 9, which extends be-

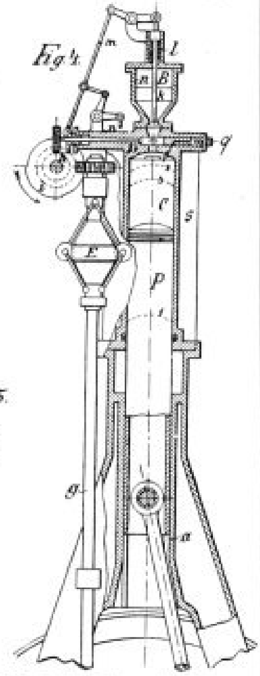


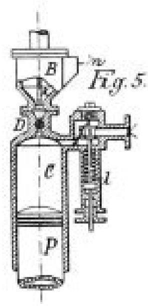
tween the tube ends to a point above the water level. The feed-water entering through the pipe 11 on the left hand side of the plate is prevented thereby from mingling with the hotter water rising through the tubes nearer the furnace, but descends through the rear rows in a less violent manner than in the main circuit, from which it is cut off by the baffle-plate, thereby giving a much better deposition of sediment. The heat of the gases is fully extracted on account of the lower temperature of the rear tubes down which the feed-water passes, while a violent circulation takes place between the front rows and these rear rows which are not cut off by the baffle-plate.

HEAT ENGINE.

No. 542,846. RUDOLF DIESEL, BERLIN, GERMANY. *Patented July 16th, 1895.* Fig. 4 is a section of the cylinder and attached working parts; Fig. 5 is a section taken at right angles to Fig. 4, and Fig. 6 is a section of the feeding valve, on a larger scale. This engine is designed to use finely ground coal, for the direct production of power, in the cylinder of the engine. Instead of burning the fuel under a boiler, as in the steam engine, or making it into gas with which to run a gas engine, the pulverized fuel is fed directly from the hopper *B*, into the top end of the cylinder, through the valve *D.* This valve is a cylindrical plug, having a pocket *c*, cut into one side, and it is revolved once in each two revolutions of the engine, by suitable gearing. When the pocket turns upward the ground coal fills the space, and as the valve revolves, the charge of coal drops into the top of the cylinder. At that instant, the piston or plunger *P*, has risen nearly to the top of its stroke, and the air in the cylinder has been compressed to such a degree that its temperature has risen above the burning point



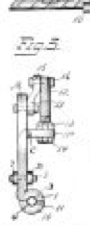




of the coal. The coal is ignited, but its combustion is controlled by the admission of air through the valve *g.* The combustion continues to about one-fourth or one-third stroke, and serves to partly maintain the pressure upon the piston, although the temperature within the cylinder actually falls. After the combustion ceases, the hot gases expand without transfer of heat, down to or even below atmospheric pressure. The gases are thus cooled by expansion, to such an extent that no artificial cooling arrangements, water jackets, etc. are needed. The range of temperature throughout each stroke is very great, and it is claimed therefore, that the economy is greater than in any other form of heat engine. The ashes being suspended in a finely divided state in the whirling gases, are blown out with them into the exhaust. The valve gear and arrangement of power cylinders and air pumps, are similar to those in ordinary gas engines.

CABLE GRIP.

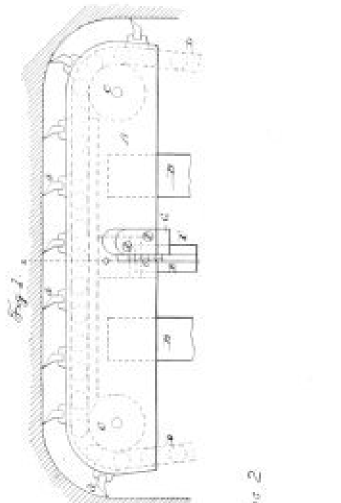
No. 549,893. R. F. BENNETT AND M. L. GEORGE, COAL CREEK, TENN. *Patented Nov. 19th, 1895.* Fig. 1 is a side view of the grip; Fig. 3 is an end view of the same, and Fig. 4 shows the application of the grip to a mine car. The grip is composed mainly of the bow *A*, which has curved lugs 1 and 2, and the hook *C.* The lever *D*, is pivoted to *A*, as shown in Fig. 3, and its upturned end is connected to *C* by an eye bolt 12. By adjusting the nuts 13 and 14, the tension of the grip upon the cable

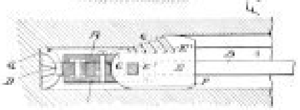


can be regulated as desired. The grip is supported by a rigid draw bar *B*, which is so connected to the car as to prevent it from falling low enough to foul the track, or from turning over. The draw bar being rigid, the cars cannot run over it when descending a grade. Thus, all rope riders are dispensed with. Two grips may be used, one at each end of a train, thus, making the connection of the cars to the cable entirely certain and safe.

MINING MACHINE.

No. 548,970. HENRY B. DIERDORFF, COLUMBUS, OHIO. *Patented Oct. 29th, 1895.* This device is designed to steady and guide the cutting head of machines which employ horizontal cutting chains for undercutting coal. It consists mainly of a saw-toothed cutter *E*, which is attached to the head plates *A.* Each tooth is higher than the one next in front, and takes but a small kerf, (about one-eighth of an inch) so that compara-

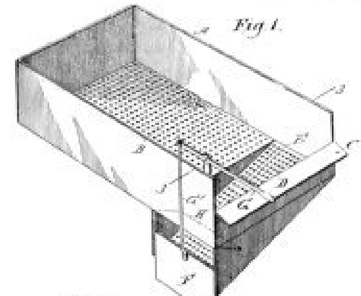


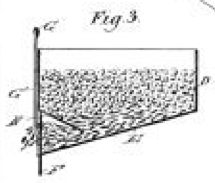


tively little force is required to drive it forward, as the cutter head advances. The cutter is made usually but ¼ inch thick and cuts a kerf ¾ inch high. This is found to be sufficient to properly guide the machine. The lower edge of the cutter is provided with a wide flange, which forms a shoe and thus supports the cutter head, and prevents it from sagging.

JIG BOX.

No. 548,665. WILLIAM O. LENTZ, MAUCH CHUNK, PENN'A. *Patented Oct. 29th, 1895.* Fig. 1 is a perspective view of the box; and Fig. 3 is a cross section through the slate box, on the line 3, 3. This pan is adapted to work with plunger jigs, in which the box is stationary and the water is moved, or with shaking jigs which vibrate the box in standing water. The lower end of the box is made into a slate pocket *E* hav-

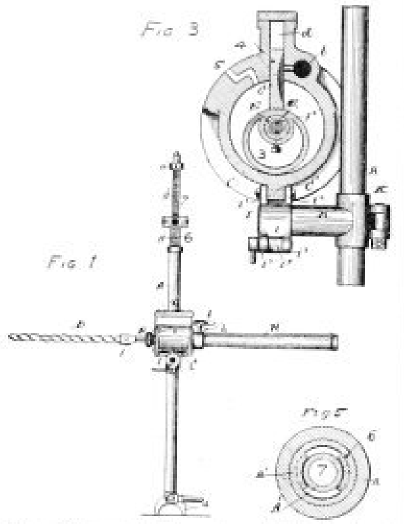




ing an inclined bottom as shown. A guard plate *H* prevents the contents from escaping too freely toward the gate *F.* In operation, the coal works to the top and flows over the lip or flange *C*, while the slate goes to the bottom and slides down past the edge of the guard plate *H*, to the gate *F.* This gate can be adjusted so as to secure a constant discharge of the slate over it thus permitting the jig to work continuously for any length of time.

COAL DRILL.

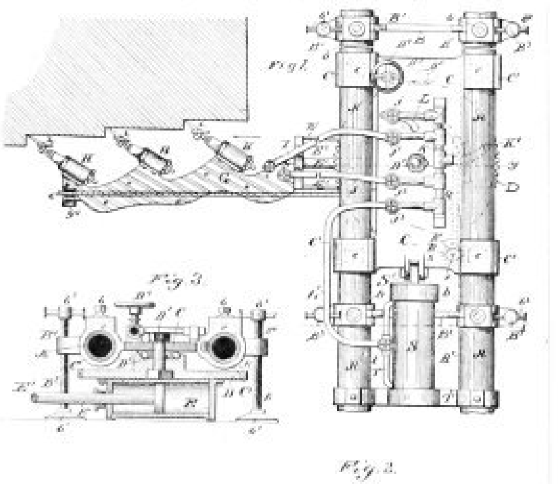
No. 551,139. EDWARD S. MCKINLAY, DENVER, COLO. *Patented Dec. 10th, 1895.* Fig. 1 is a side view of the machine ready for work; Fig. 3 is a cross-section of the motor on a larger scale; and Fig. 5 is a cross-section of the post. The motor is a rotary engine, and it is driven by steam or compressed air. The cylinder *C*, is divided by a partition into two chambers, in each of which there is a rotating piston 3, and a reciprocating plate 4. The pistons 3, are secured to the hollow shaft *E*, one opposite the other, so that the driving motion shall be nearly uniform. The shaft *E*, is provided with suitable feathers which engage grooves in the drill rod *R*, or is made to fit directly upon the spirals of the auger. In the latter case the machine may be operated very close to the face. Steam or air enters the motor at E', and exhausts at 5. The rear end of the auger, or drill rod is attached by a swivel joint to a piston, which moves within the feed cylinder *H*. Air or steam pressure is used to feed the auger into the cut. The post is made in three parts. The rod 7, is screwed into a long nut 6. The threads on the rod, and in the nut, are cut away, as shown in Fig. 5. In the position shown, the rod may slide in or out freely, and by turning it through one quarter of a revolution its threads are made to engage the threads of the nut. The post is then tightened in place by turning the nut 6. The outside of the nut is threaded into



the top of the post *A*. The motor and drilling mechanism are mounted upon a knee *I*, which may be clamped at any point upon the post *A*, by means of a clamp *K*.

MINING MACHINE.

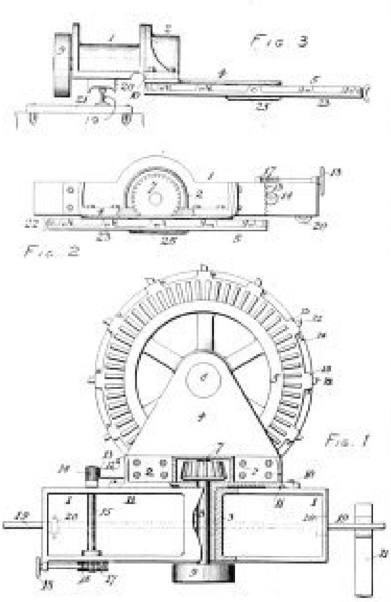
No. 550,896. Edward S. McKinlay, Denver, Colo. *Patented Dec. 3rd, 1895.* Fig. 1 is a top view of the machine; Fig. 2 is a sectional end view; and Fig. 3 is a cross section on the line *x*, *x*, of Fig. 1. The cutting mechanism which is employed in this machine consists of a number of small independent chiseling machines *H*, which are driven by compressed air, and are rigidly mounted on an arm *G*. This arm is attached to the machine by a center pin B^6, and it can be



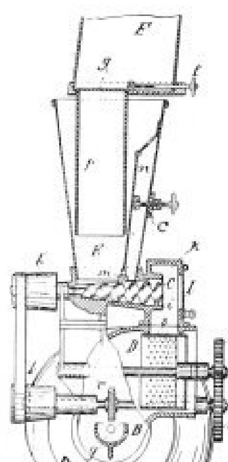
swung around through a considerable angle by means of the gear *D*, worm D^2, and hand wheel D^3. It is mounted upon a sliding frame which passes around each side of the cylinder *E*. By admitting air into the rear end of the cylinder the arm *G* is moved bodily forward, at right angles to the face of the coal. The cutting apparatus is mounted upon a slide or cross head *C*, which is movable upon the main frame bars *A*, *A*. It is attached to the piston rod of the feed cylinder *S*. When the arm *G* is pushed out to its furthest extent, it automatically reverses the valves upon the cylinder *E*, and it is at once drawn back. As it reaches the inner end of its travel, it trips a pawl *Q*, and thus releases the ratchet wheel *R*, and permits it to turn forward one tooth. The ratchet wheel is attached to the feed pinion R^1 which engages the rack R^2 upon the rear bar of the main frame. As soon as the ratchet is released, the pressure in the cylinder *S* drives the crosshead forward one step, and thus moves the arm *G* along, in a direction parallel to the face. The cutting cylinders *H*, are provided with long heavy pistons which have a very short stroke. Each piston rod carries a gang of chisels *N*, as shown, and the strokes are made with great rapidity. The chips are removed by means of the chain *c*.

CUTTER WHEELS FOR MINING MACHINES.

No. 550,944. William J. E. Carr, Leavenworth, Kansas. *Patented Dec. 10th, 1895.* Fig. 1 is a top view of the wheel and its mountings; Fig. 2 is a front, or edge view of the same;



and Fig. 3 is a vertical side view. This wheel is designed to operate like a circular saw, and in undercutting coal it is forced forward until the box on the pinion 7 encounters the face. The wheel is rotated by means of the teeth sunk in its upper face, and the pinion 7, shaft 8 and pulley 9. The main frame 1, has shoes 20, which ride upon the single rail 19. The frame 2, has circular V edges 11, which are clamped by the gibs 10. One end of the frame has a toothed sector 13, which engages the pinion 14. By turning the handwheel 18, the pinion may be revolved, and the saw frame may be inclined to any angle desired. As the shaft 8, lays in the axis of the center pin 3, about which the movement is made, the gears will mesh properly and will not be affected by the change of position.

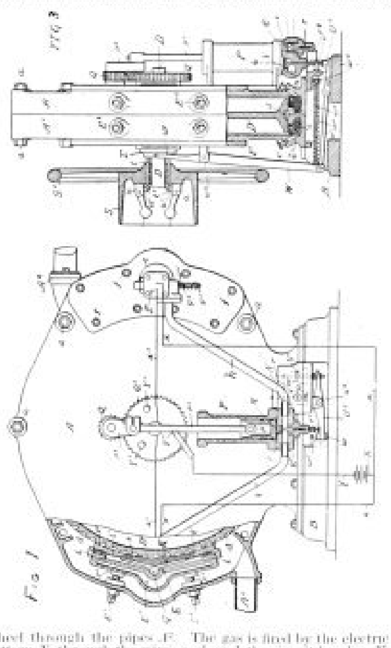


FEEDING COAL DUST.

No. 551,674. Ferdinand De Camp, Berlin, Germany. *Patented Dec. 10th, 1895.* This machine is designed to feed pulverized fuel into the furnaces of steam boilers, etc. The fuel is held in a bin *F*, and is delivered through a gate *g*, and chute *p*, into the hopper *E*. The sides of the hopper converge to a narrow slit, and discharges onto a tapering spiral conveyer *C*. The length of the opening may be varied by moving the block *m*, by means of the screw *z*, and lever *n*. As the fuel is discharged into the chamber *k*, it falls onto the perforated rim of the drum *D*, which is rotated by the gearing shown. All lumps are thus broken up and the fuel falls into the interior of *D*, in a shower of dust. The air which supplies the fan *A*, passes through the drum and carries the fuel with it. The fuel is thus divided properly, and is mixed with enough air to ensure good combustion; and is driven through the outlet *a*, into the furnace. The speed of the feeding spiral *C*, may be modified by shifting the belt upon the cone pulleys *bb'*.

GAS TURBINE.

No. 550,742. Wesley R. Campbell, Philadelphia, Penna. *Patented Dec. 3rd 1895.* Fig. 1 is a sectional side elevation; and Fig. 3 is an end view, also partly in section. This motor consists mainly of a wheel having a great number of small buckets formed in its rim, and two opposite gas chambers, in which gas is exploded at very short intervals. The exploding gas is directed by guide plates *K*, so that a considerable part of its force is spent upon the buckets *d*, in the rim of the wheel, thus causing it to revolve with great rapidity. The gas is mixed with air and is forced by the pump *P*, through the pipes *N*, into chamber *E*, one upon each side of the wheel. Here it is exploded, and passing through the channel *G*, is received by the guide plates *K*, and directed upon the wheel. Six explosions are made to each revolution of the wheel, three in each gas chamber, thus they follow each other so closely that the impulses given to the wheel are practically continuous. The governor *S*, controls the valves of the pump *P*, by means of the lever *W*, and wedge *w*, which limits their movement. The spent gases escape from the

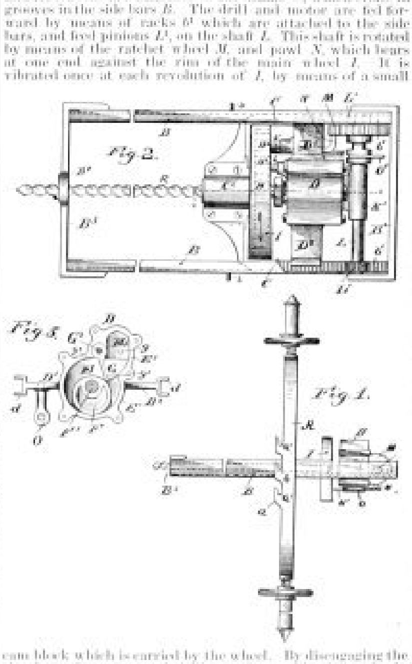


wheel through the pipes *F*. The gas is fired by the electric battery *X*, through the wires *x*, x^1, and the circuit breaker *Y*. The rim of the wheel is cleaned and lubricated by an oil pad *Z*, as shown in Fig. 3.

COAL DRILL.

No. 550,892. Benjamin A. Legg, Columbus, Ohio. *Patented Dec. 3rd, 1895.* Fig. 1 is a side elevation of the complete machine; Fig. 2 is a top view of the motor and drilling mechanism on a larger scale; and Fig. 5 is a cross section of the motor.

The motor is a rotary engine, which may be driven by compressed air or steam. It has two working chambers, each of which contains a rotating piston *F*, and a vibrating sector *G*. As *F* turns round, *G* moves in and out of the chamber E^2. The main spindle F^1 carries a pinion *H* on its front end, which drives the internal gear *I*, by means of an idler pinion H^1. The spindle of the wheel *I* turns in the bearing C^2, and the auger *B*, is attached to it by a suitable socket. The motor and feed works are attached to the frame *C*, which slides in grooves in the side bars *B*. The drill and motor are fed forward by means of racks b^1 which are attached to the side bars, and feed pinions L^1, on the shaft *L*. This shaft is rotated by means of the ratchet wheel *M*, and pawl *N*, which bears at one end against the rim of the main wheel *I*. It is vibrated once at each revolution of *I*, by means of a small



cam block which is carried by the wheel. By disengaging the clutch *O*, the motor and drill may be readily drawn back. The main frame *B* is supported on trunnions *b*, in notches on the post *A*, which is double.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 8. SCRANTON, PA., MARCH, 1896. With Which is Combined THE MINING HERALD.

ANTHRACITE MINING

AT THE SOUTH WILKES-BARRE COLLIERY.

Geological Features, Methods of Mining, Ventilating and Drainage, Etc., at an Anthracite Colliery of Large Capacity.

Written for THE COLLIERY ENGINEER AND METAL MINER by W. W. Jones, Mining Engineer.

This colliery is located in the southern portion of the city of Wilkes-Barre, Pa., and near the center of the western half of the Northern or Wyoming-Lackawanna anthracite coal field.

It is one of ten collieries owned and operated by the Lehigh and Wilkes-Barre Coal Co., in the Wyoming region, among which it ranks second in point of production—(The Nottingham colliery at Plymouth, Pa., being the largest producing colliery of this company)—and gives employment to 1,000 men and boys.

The breaker prepares a superior grade of coal, and being situated as it is in the midst of a thriving city of about 50,000 population, it naturally enjoys an extensive retail trade in addition to its regular line shipments.

The surface openings consist of two hoisting shafts, Nos. 3 and 5 respectively, and one air-shaft.

No. 5 shaft, which is located at the corner of Parrish and High streets, was sunk in 1888 to the Baltimore vein a depth of 1,040 feet. It is 12′x52′ in size and is divided into 5 compartments. (See Fig. 3). A downcast airway 12′x12′, 2 hoist-ways each 7½′x12′, a man-way or pump-way 7½′x12′, and an upcast airway 14′ 10″x12′. From the surface down to solid rock, a distance of 30 feet, it is double timbered. On the outside, next to the wash, sets of 12″x12″ timber are placed 3 feet between centers and sheeted on the outside with 2-inch plank. On the inside next to the shaft, sets of 10″x10″ timber are placed "skin to skin" from the surface line to solid rock and 5 feet between centers from there down to the bottom of the shaft. The cross buntons (A, Fig. 3) between compartments are of 8″x10″ timber. A clear space of 12″ is left between the inner and outer sets of timbers which is filled with concrete from the solid rock to the surface line.

No. 3 shaft is located about 400 feet northeast of No. 5 shaft and was first sunk to the Hillman vein a depth of 700 feet and afterward extended to the Baltimore vein 267 feet deeper, or to a total depth of 967 feet. There is a landing in this shaft at the Hillman vein, but none at the Baltimore vein, that portion of the shaft extending below the Hillman vein being used only as an air-way or second opening for the Baltimore vein workings from No. 5 shaft. From solid rock to the surface line the No. 3 shaft is walled with a 5-foot wall of substantial masonry. Aside from this it is timbered similar to No. 5 shaft.

Each shaft is provided with electric signaling bells and the mine foreman's office on the surface is connected with the fire-boss's station at the foot of each shaft by telephones.

The topography of the coal beds in this region is marked by numerous anticlinals and basins (See Fig. 2) lying nearly parallel and extending in a southwesterly direction, the tops of the anticlinals and the bottoms of the basins descending more or less toward the west.

The most prominent flexures defined by the workings of this colliery are the South Wilkes-Barre basin with the Stanton air-shaft anticlinal (See Fig. 12, Map), the South Wilkes-Barre anticlinal immediately to the south of this basin, and the Buttonwood anticlinal to the north of it.

Fig. 12 also shows the shafts, gangways and airways, slopes, planes and tunnels, but not the breasts. The gangways in the Baltimore vein are shown in solid lines and those of the Hillman vein in dotted lines.

The average width of the South Wilkes-Barre basin in that portion of it extending east of No. 5 shaft is about 1,400 feet while in its western portion it has a width of about 3,000 feet.

This basin extends westward several miles, and into this and also into the basin lying north of the Buttonwood anticlinal the workings of this colliery will extend.

The depth of this basin at a point immediately to the north of No. 5 shaft is 930 feet below sea level or 1,470 feet below the surface. In the lowest or Red Ash vein and at a point 5,000 feet west of No. 5 shaft and opposite the western extremity of the present workings the bottom of this basin is 1,100 feet below sea level, or 1,640 feet below the surface, in the same vein.

Mining has thus far been confined almost entirely to two veins—the Hillman and Baltimore, though gangways, but no breasts have been opened in three other veins—the Stanton, Five-foot and Kidney. (See Fig. 2.)

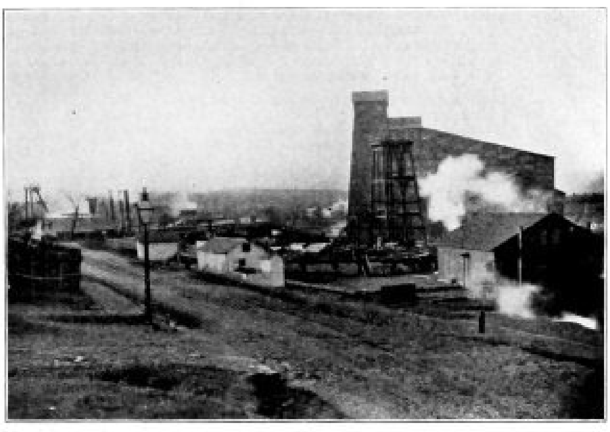


FIG. 1. GENERAL VIEW OF OUTSIDE IMPROVEMENTS, SOUTH WILKES-BARRE COLLIERY, LOOKING WEST.

The positions of these veins in relation to each other, as well as all the veins in the coal measures, are shown in Fig. 2 which is a section through the workings of this colliery on the line shown in Fig. 12.

The workable veins in this vicinity may be summed up as follows, commencing with the lowest and naming them in the order of their occurrence upward: 1, Bottom Red Ash, 12ft.; 2, Top Red Ash, 6 ft.; 3, Ross, 6 ft.; 4, Skidmore, 6 ft.; 5, Baltimore, 16 ft.; 6, Five-foot, 5ft.; 7, Stanton, 5 ft.; 8, Hillman, 8 ft.; 9, Kidney, 6 ft.; 10, Abbott, 6 ft.; making a total of 76 ft. of coal. At a point in the middle of the South Wilkes-Barre basin, 3,500 ft. west of No. 5 shaft, a diamond drill hole showed, in addition to the above, several smaller veins overlying these and aggregating about 25 ft. which will most likely be mined sometime in the future.

The No. 3 shaft cut the veins nearly on the crest of the South Wilkes-Barre anticlinal, while the No. 5 shaft cut them on the north dip of the shallow basin lying between the two shafts. From both shafts gangways are driven east and west; those from No. 3 shaft being in the Hillman vein and those from No. 5 shaft in the Baltimore vein; from which it is to be understood that through No. 5 shaft, the coal is hoisted from the Baltimore vein and through No. 3 shaft, from the Hillman vein.

The east gangways from both shafts follow along the north dip of the South Wilkes-Barre anticlinal and have a total extent eastward of 4,400 ft. From these gangways breasts are driven on a south rise of from 20° to 25° to the crest of the anticlinal, or till they reach the barrier pillar separating the workings of this colliery from those of the Stanton colliery, and having a length of from 300 to 500 feet.

From the east shaft level gangway, Hillman vein, a slope 500 feet long was driven in the vein, on a north dip of 20°, to the bottom of the South Wilkes-Barre basin. From the foot of this slope three gangways were driven, two going west, one on each side of the basin, and one going east up along the bottom of the basin. A gangway was also driven east from the slope about half way down.

This slope was afterward continued a distance of 300 feet across the measures on a north dip of 20°, cutting the Stanton, Five-foot and Baltimore veins on the south dip, in each of which gangways were driven.

From the east shaft level Hillman vein gangway, above referred to, a tunnel 700 feet long was driven north across the South Wilkes-Barre basin to the Hillman vein on the south dip. This cut the Kidney vein also on both dips, near the middle of the basin. A gangway was driven east in the Kidney vein and one west in the Hillman vein.

This tunnel is now being extended, till it shall cut the Hillman vein again on the north dip of the Buttonwood anticlinal. It having already cut the Stanton and Five-foot veins on the south dip and the Five-foot vein on the

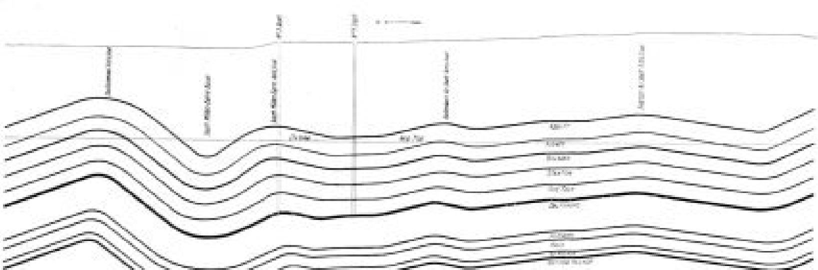


FIG. 2. CROSS SECTION THROUGH SOUTH WILKES-BARRE COLLIERY, LOOKING EAST. SCALE 1 INCH=800 FEET.

north dip also, it, when finished, will have opened up a vast extent of coal on the north side of the Buttonwood anticlinal.

From the No. 5 shaft level east gangway, a slope is being driven in the Baltimore vein going westward along the crest of the South Wilkes-Barre anticlinal on a dip of 12°. This will be continued to the bottom of the main South Wilkes-Barre basin.

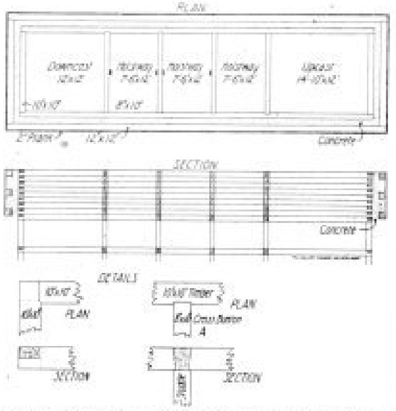


FIG. 3. PLAN AND SECTION OF NO. 5 SHAFT SHOWING METHOD OF TIMBERING.

The No. 3 shaft west gangway after going east about 300 feet struck an upthrow; after some time spent in proving the nature and extent of the disturbance, a tunnel 300 feet long was driven south through the anticlinal, cutting the vein again in its usual condition. The gangway then continued south 300 feet till it struck the north dip of the Hollenback air-shaft anticlinal and continued thence westward along the north dip 700 feet

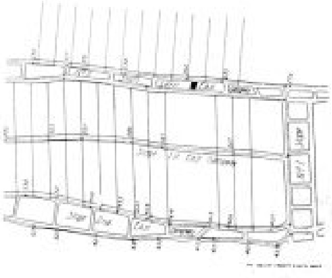


FIG. 4. METHOD OF LAYING OUT BREASTS.

to the crest of the anticlinal, and thence eastward again 700 feet to a basin, and thence directly westward 3,600 feet along the north dip of the Stanton air-shaft anticlinal, and then doubles back eastward again along the south dip 2,000 feet to the bottom of a basin.

The west gangway from No. 3 shaft went regularly westward along the north dip till it rounded the crest of the Stanton air-shaft anticlinal 4,800 feet west of the shaft, and then doubled up on itself in passing to the north dip of the next anticlinal to the south.

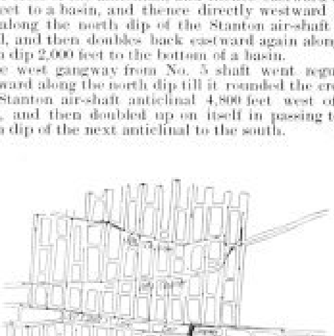


FIG. 5. PLAN OF WORKING BREASTS.

From the west Hillman vein gangway, breasts are driven either to the top of the anticlinal or till they reach the barrier pillar separating these workings from those of the Stanton colliery. The breasts are from 300 to 500 feet long on a dip of from 6° to 15°.

From the west Baltimore vein gangway, the workings extend by three lifts—the shaft level, the No. 1 plane level, and the No. 2 plane level—till they either reach the tops of the anticlinals or the barrier pillar above referred to. The width of this barrier pillar is 50 feet in the Baltimore and 40 feet in the Hillman vein.

From the shaft level west gangway, at a point 900 feet west of No. 5 shaft, No. 1 plane, 650 feet long, was driven in coal on a south rise of 9° and gangways driven east and west. From this No. 1 plane west gangway, No. 2 plane, 500 feet long, was driven in coal on a south rise of 6°, reaching the crest of the anticlinal. From this plane two gangways were driven, both going eastward, one on each side of the anticlinal.

Three thousand, five hundred feet west of No. 5 shaft, No. 1 tunnel, 700 feet long, was driven north from the Baltimore vein, cutting the Five-foot and Stanton veins on the north dip. In these veins gangways were driven. One thousand feet west of this No. 1 tunnel, a second or No. 2 tunnel, 350 feet long, was driven north from the Stanton vein to the Hillman vein, cutting it also on the north dip and near the middle of the South Wilkes-Barre basin.

Two hundred feet west of the first or No. 1 tunnel a rock plane 200 feet long was driven on a north rise of 20° from the Stanton to the Hillman vein. About 1,600 feet northwest from the point where No. 2 tunnel cuts the Hillman vein the No. 1 air-shaft is located. This shaft is 12'x37' in size and was sunk to the Hillman vein, cutting it on the south dip at a depth of 674 feet. From this a trial slope was driven in the vein on a south dip of 30° to the level of the tunnels just referred to. An outlet is now being driven in the Hillman vein from the No. 2 tunnel west gangway through the basin to the bottom of the trial slope from the air-shaft.

These tunnels are all 12 feet wide and 7 feet high above the rail.

"Up to the time of the completion of No. 5 shaft in 1888 the workings were confined to the Hillman vein from No. 3 shaft, and mainly to the west gangway from this shaft. At this time the workings comprised about 2,000 feet of gangway driven in the solid and having airway, and 300 feet of tunnel in rock.

When No. 5 shaft was completed the work of opening up the Baltimore vein was immediately begun, and another gangway also was started in the Hillman vein from No. 3 shaft. From that time on to the present the workings have expanded rapidly, and especially since the completion of the breaker, prior to which the coal mined here was taken to the Stanton breaker, where it was prepared for market.

In order to show the rapid growth of the colliery since the completion of No. 5 shaft, the present extent of the entire workings is shown, as follows:

Total length of gangways driven in solid and having airways	11 miles
Total length of planes and slopes in coal	2,300 feet
Total length of tunnels, outlets, and slopes in rock	4,000 "
Total number of breasts including those working and those stopped	401 "

The method of working here is the usual breast and pillar method. Gangways, usually 12 feet wide by 7 feet high, are driven on a grade of 6" per 100 feet, each gangway driven in the solid having an airway of the same size driven parallel with and separated from it by a pillar of from 10 to 20 yards, through which headings are driven every 20 to 30 yards for the purpose of ventilation.

Breasts are opened directly from the gangways and driven a uniform width of 24 feet, commencing with a width of 14 feet at the gangway and widening to the full breast width at 20 feet from the gangway. These are also connected by a heading every 20 to 30 yards for ventilation.

The breasts are worked usually in panels of ten breasts each, leaving a pillar between each two successive panels the width of three breasts, and the pillar in one vein is left immediately over or under that in another vein. All the breasts are driven in accordance with a previously prepared plan. See Figs. 4 and 5. This plan has the center lines of the breasts laid off on the gangways at uniform distances apart and parallel throughout each panel or throughout as many panels in succession as the dip of the vein will allow, changing the course of the breasts only when the lay of the vein compels it. On each center line is marked its course and also its distance from a station on the gangway—this distance to be measured in the gangway from the station.

In the Hillman vein the center lines are uniformly 50 feet apart, and in the Baltimore vein 65 feet apart, except where the vein is divided and is worked in separate splits, where the centers are 60 feet apart, and those in the top split are immediately over those in the bottom split. The point at which the Baltimore vein divides is 2,000 feet west of No. 5 shaft. From this point westward the vein is worked in two splits.

The gangways are made the main haulage roads; the coal from the airways being brought to them through cut-offs driven at suitable distances apart. After each cut-off is driven the portion of the airway outside of it is thereafter used only as an air course.

The motive power employed in moving the cars along the gangways is mules, but in the near future when the workings at a distance from the shafts will be sufficiently developed to require it, some system of rapid transit will be put in use.

There are three general methods of working breasts in use at this colliery. These are:

1. The road breast, where the vein dips less than 10°. (See Fig. 8).

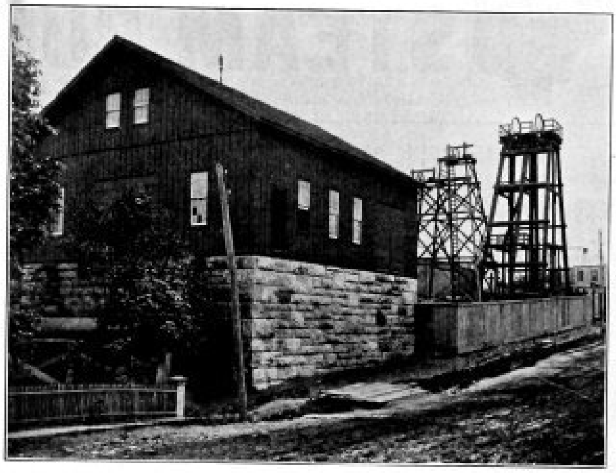


FIG. 6. NO. 5 SHAFT ENGINE HOUSE AND HEAD FRAME.

2. The shute breast, where the vein dips from 12° or 15° to 35° or 40°. (See Figs. 9, 10 and 11).
3. The battery breast, where the vein dips from 40° to 90° or vertically. (See Fig. 13).

The road breast is used to some extent in the western workings on the north dip. In this the car is taken directly to the working face on a road laid from the main haulage road on the gangway into the breast. Where this method is used here the breasts are driven nearly at right angles to the gangway, and the roads are laid in the middle of the breasts.

The shute breast is the one in most general use here. This admits of a good many modifications to suit the varying pitches and peculiar conditions of the vein. Figs. 9, 10, 11 and 13 show the principal modifications.

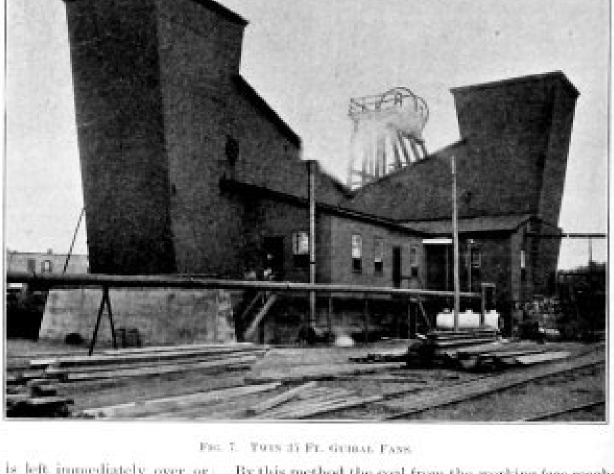


FIG. 7. TWIN 35 FT. GUIBAL FANS.

By this method the coal from the working face reaches the car by sliding down a sheet-iron shute to a platform or apron at the gangway, from which it is shoveled into the car; or, if the dip and thickness of the vein will admit, the shute is built out over the gangway far enough to allow the coal to run directly into the car.

As soon as the breast is opened off the gangway the platform is built as near the height of the car as the conditions will allow in order to lessen as much as possible the labor of shoveling the coal from it into the car.

From this platform the sheet-iron chute is continued up the breast as the working advances, and is kept within 10 or 15 feet of the face.

Coal runs readily on sheet-iron laid on a dip of 18°. The shute is therefore kept on this grade wherever the

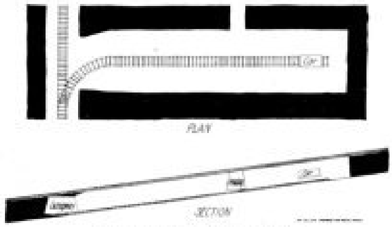


FIG. 8. SEAM 8' 0" THICK, DIP 8°.

conditions will admit. If the vein dips 18° or more—up to 30°—the shute is laid on the bottom of the breast, and if the vein dips as high as 35° to 40° the coal will run on the bottom without the sheet-iron. But, if the vein dips less than 18°, the shute is kept at the proper grade by gradually raising it from the bottom as it advances up the pitch, by building it up between two rows of props set at the proper distances apart. (See Fig. 11).

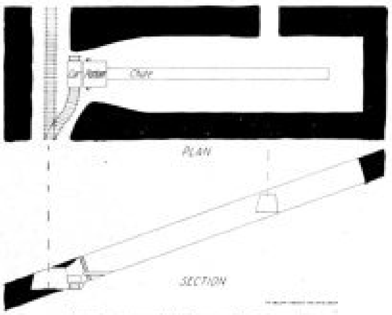


FIG. 9. SEAM 8' 0" THICK, DIP 18° TO 25°.

In a good many breasts the shute thus gets too high to shovel the coal into it at the face, in which case it is discontinued and a scaffolding or wheelbarrow run is extended from the shute into the face. Over this the coal is thereafter wheeled from the working face and dumped into the shute. Wheeling, however, is resorted to only for short distances.

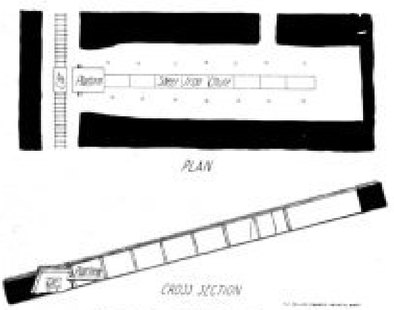


FIG. 10. SEAM 7' 0" THICK, DIP 16°.

Where several shute breasts in succession reach an extended light dip they are stopped at that point till crossed by a slant or counter-gangway, from which they are again continued as either road or shute breast, according to the dip. (See Fig. 5).

Building up the shute in order to get sufficient grade to run the coal down by gravity, as just described, can

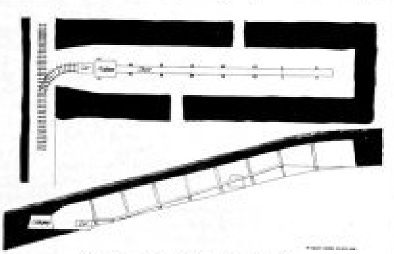


FIG. 11. SEAM 16' 0" THICK, DIP 15°.

only be done where the vein is thick enough to afford sufficient height, which is the case only in the Baltimore vein where it is not divided, it having a thickness there of 16 feet. Where the Baltimore is worked in two splits

FIG. 12. MAP SHOWING GANGWAYS, TUNNELS, SLOPES, ETC. SCALE 1 IN. = 800 FT.

—the top split being 7 feet and the bottom 8 feet thick, and also in the Hillman vein, which is 7 feet thick as first worked up—the bony bench of about 3 feet is always left up to secure a good roof. The shute must be laid always on the bottom of the breast. Then, if the vein dips 18° or more, the coal, of course, slides down the shute itself, but if the vein dips less than 18° it must, of necessity, be pushed down the shute by hand, the amount of labor thus expended depending on the lightness of the dip.

Nearly all shute breasts in the Hillman, and also in the two splits of the Baltimore vein, have a branch or siding laid in front of each, on which the car is placed away from the haulage road while being loaded. (See Fig. 9).

Where the Baltimore vein is not divided, the gangways are usually driven in the upper benches of the vein and the breasts are worked up in the bottom benches, leaving the upper or "three foot" bench to be taken down after the breast is worked to its limit, by "drawing back," *i. e.*, by commencing at the face of the breast and working toward the gangway.

This top bench is left up to secure a good roof under which to work the breast up, as the slate overlying the vein makes a bad roof.

In the Hillman vein the top or bony bench is also taken out after the breast is finished, provided there is enough good coal in it to warrant the extra work.

By driving the gangways in the upper benches of the Baltimore vein, the road breast is thus afforded a very easy grade on which to lay the branch into it, and the shute breasts consequently have a road laid from 25 to 50 feet into them before the bottom of the vein, where the platform is built, is reached.

In a few breasts on the No. 3 shaft level east gangway, Hillman vein, the dip of the vein suddenly changed from 20° or 25° to 45° or more after the breasts had advanced by the usual shute method about 125 feet from the gangway. (See Fig. 13.) From the point where the heavy dip commences they were "worked full" or by the "battery" method, as follows: A row of heavy props was set nearly perpendicular to the dip of the vein and extending across the middle of the breast. These were lagged from bottom to roof and formed the beginning of the battery.

A row of props was then extended up the breast from each end of this battery, leaving a space of 3 or 4 feet clear of the rib on each side of the breast for manways and also as airways.

These rows of props were lagged or planked on the side next to the battery and were kept well up to the face.

The coal as it is mined is allowed to remain in this battery, only the surplus coal not needed to keep the battery filled being allowed to go down the manways to be loaded into the cars at the gangway.

The manways have lagging placed across them on the bottom every 4 feet, to answer for steps by which to climb up or down.

After the breast has been thus worked up to its limit, the battery is opened at the bottom and the coal loaded out.

The arrangement of tracks on No. 1 plane is shown in Fig. 14, which is the form of gravity plane in general use in the collieries of this company. A wooden lagged drum provided with a brake and having two ropes attached is located at *I* a sufficient distance back from the knuckle or apex, to allow the branches to be laid with easy curves.

One rope, after being coiled upon the drum, has the loose end attached to a loaded car at the apex; and the other rope which is extended down the plane has its loose end attached to an empty car at the foot. The loaded car is then allowed to move down the plane, thus pulling the empty car up, the speed at which they move on the plane being regulated by the brake on the drum.

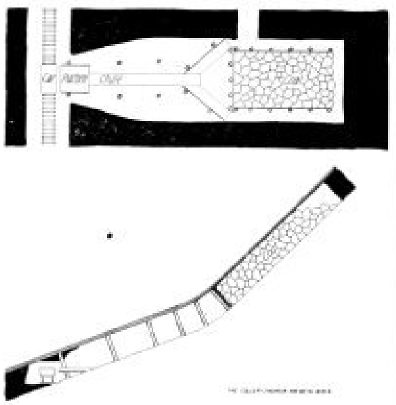


FIG. 13. SHUTE AND BATTERY BREAST.

At this plane the loaded branches at the head have a down grade from the frogs at *a a'* to the apex; commencing with a grade of a little less than one degree and gradually increasing to a degree or perhaps a little more as they approach the point *b*. The empty branches at the head have an up grade from the latches at *D* to the frogs at *a a'*, amounting to about the usual gangway grade of 6" per 100 feet.

The loaded branch at the foot has a down grade of about one degree from the foot of the plane to the frog at *C*, and the empty branch commences at the frog *C* with a slight down grade which, as it gets near the bottom of the dish, increases to one degree.

The latches at *a*, *a'*, *D*, *D'* and *C* are moved by hand to enable cars to be shifted from one branch to another as is frequently necessary. The latches *E* are spring latches set to run the car coming down the plane always on the loaded branch. The latches at *F* are operated by the footman at *H* by a lever connected to the latches *F* by an arrangement of rods. The latches at *G* and *b* are also operated by levers by the headman. The grade of this plane is 9° and that of No. 2 plane is 6°. Two and three-car trips are handled on each. The reason why the branches at the foot of this No. 1 plane extend in the line of the plane is because the vein lays very flat at that point, and by making the foot in the bottom and the head in the top of the vein, sufficient room was gained to arrange the branches as they are shown in Fig. 14.

No. 1 slope is operated by an engine located on the surface about 50 feet south of No. 3 shaft. The rope, which is 1¼" diameter, passes down this shaft and in along the gangway to the slope. At the top and bottom of the shaft it passes round 5 ft. sheaves set vertically and along the gangway it is carried overhead on 6" pulleys suspended from the roof. Between the shaft and the slope, a distance of 500 feet, it makes three turns, at each of which a 3 ft. sheave is placed horizontally, and at the point where it leaves the gangway to pass down the slope a 5 ft. sheave is placed on a sufficient slant to accommodate the pitch of the rope when it is stretched over the apex.

The head of this slope is arranged to land the cars directly on the loaded branch by hoisting them over the apex, which is the general practice under this company.

As has been noticed, all gangways and airways, as well as breasts, are connected by headings for the purpose of ventilation. As each new heading* is opened the one just passed is closed, so that all headings but those next the faces are closed. All headings between gangways and airways and all other headings which are closed for the purpose of separating the different splits of air are closed with a wall which is made of stone laid in mortar and from two to three feet thick.

All temporary stoppings between places in the same split, as well as all brattices of any great extent, are built of boards.

The usual arrangement of doors and brattices in ventilating a portion of workings, consisting of a panel of breasts and a gangway and airway, is shown in Fig. 15. In this case the gangway is the intake and the airway the return.

In order to keep the air current against the faces of the gangway and airway as they advance from one heading to where the next one will be opened, a door is placed across the gangway just outside the last heading and connected to the lower rib by brattice. (See *A*, Fig. 15.) From the opposite ends of the door a brattice is extended along and about three feet from the upper rib and kept within a few feet of the face.

In the airway a brattice is extended from a point in the upper rib just outside the last heading in the airway to within a few feet of the face, leaving a space of about three feet between the brattice and upper rib.

The air in going from the gangway to the airway is obliged to travel in around the ends of these brattices and is thus carried directly against the faces.

To ventilate a panel of breasts which are connected by headings a door is placed across the mouth of each breast except the first and last in the panel, and a door is also placed across the gangway just inside of the first breast and likewise one across the gangway just outside of the last one.

The air will then pass from the gangway up the first one, and through the last headings from one breast to the next and down the last one, and so on in the gangway.

It is generally found necessary in ventilating a panel of breasts to place a door across the gangway at every fourth breast in addition to those at the first and last breasts in the panel. As the faces of breasts extend beyond the headings far enough to require it, a door and brattice is placed in the first breast of the panel, (See *B*, Fig. 15) in the same manner as in the face of the gangway, while in the rest of them brattices only are used and arranged like the one in the face of the airway. This is assuming that the breasts are road breasts that are working. If they are abandoned the doors are substituted by brattices. If they are shute breasts that are working, no doors are to be placed across them, but an opening is left in each brattice crossing a breast, sufficient to accommodate the shute; over this opening and hanging down into the shute is placed a curtain of brattice cloth, and if these breasts are abandoned the brattices are, of course, made solid.

In ventilating a single breast or one with no headings, a door is placed across the gangway and a brattice extended from it up along the side of the breast. (See *C C* Fig. 15).

This colliery is ventilated by a 35 ft. Guibal fan, which making 45 revolutions per minute, exhausts 275,000 cu. ft. of air, with a water gauge of 1.9 inches. An average of several tests of the amount of explosive gas in the main return (which were made with the Shaw Gas Tester) showed it to be 2.5 per cent. This amounts to a total of 6875 cu. ft. of gas per minute, or the enormous quantity of 9,900,000 cu. ft. in 24 hours. This readily shows this to be a very gassy mine, and probably the most gaseous in the world. Owing to the great amount of gas generated in this mine the stoppage of the fan for but a very short time would result in making the air of the mine explosive and absolutely unsafe. Therefore, to provide for maintaining a constant and uninterrupted ventilating current, the fan is built in duplicate; each fan being separate and independent of the other, but similarly connected with the upcast, and capable of immediate use in the case of the other fan being stopped either for ordinary repairs or as the result of accident. (See Fig. 7).

This gas is given off from the coal in the working faces of the gangways and airways, and also in the faces of some breasts, as well as from feeders which are found in various parts of the mine, but mainly along the bottoms and lower ribs of airways. The places which give off most gas, however, are the working faces of gangways and airways, and of these the ones driven east along the heavier dips gave off the most. Generally, as the breasts are opened up along the gangways and the workings expand, the gas drains off sufficiently to permit the use of naked lights in the breasts, and also along the main gangways at a good distance back from the face.

Leading into every gangway and into some breasts is a line of 2½" water pipe, and in some gangways there are two lines, to be used in extinguishing fires that sometimes occur in spite of the extreme precautions taken to prevent them—all blasting in gassy places being done with dynamite fired by an electric battery, and the most rigid rules enforced in regard to the handling and use of explosives and in the use of naked lights. Yet fires do sometimes occur which require not only the united efforts of two streams of water for several hours, but also the closing of regulators on some splits in order to furnish additional air to the men fighting the fire.

* Small cross-cuts through pillars of coal.

It has been noticed that one compartment of No. 5 shaft is an upcast; this constitutes the upcast for the entire colliery. The balance of No. 5 shaft and all of No. 3 shaft constitutes the downcast or intake for the entire colliery.

The air entering the mine through No. 5 shaft ventilates the Baltimore vein or No. 5 shaft workings and is divided into six splits. (See Fig. 16.)

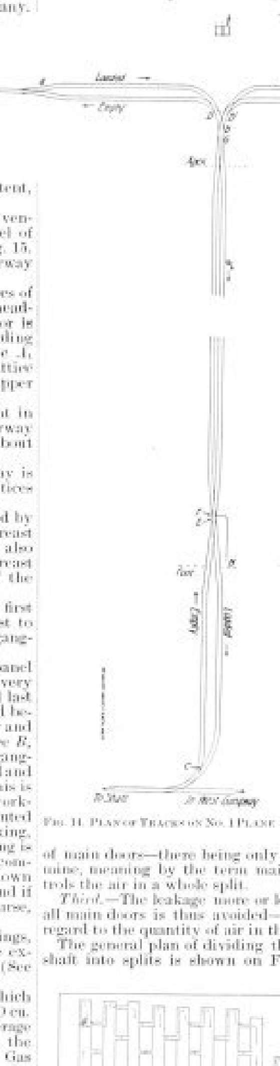


FIG. 14. PLAN OF TRACKS ON NO. 1 PLANE.

The air entering the mine through No. 3 shaft ventilates the Hillman vein or No. 3 shaft workings and is divided into four splits. So that in all there are ten splits.

In eight of these splits the air travels in through the breasts and gangways and returns through the airways, while in two of them it travels in through the airways and returns through the gangways and breasts.

The main advantages in making the breasts and gangways the intake and the airways the returns are:—

First.—The gas which is being given off at the faces of the gangways and airways and from the blowers along the airways is thus carried away from and not toward the naked lights, as no naked lights are allowed in any return showing a large percentage of explosive gas.

Second.—The air travels through the workings at a more uniform velocity on account of the absence of main doors—there being only four main doors in the mine, meaning by the term main door, one which controls the air in a whole split.

Third.—The leakage more or less which is incident to all main doors is thus avoided—giving better results in regard to the quantity of air in the several splits.

The general plan of dividing the intake air from each shaft into splits is shown on Fig. 16. The solid lines represent the intakes and the dotted lines the returns. The figures at the points of divergence of the solid lines are the distances in feet of each division of the intake air from the downcast. On each line representing a single split is its name, which indicates to some extent the territory which it ventilates, while the numbers at the ends of the solid lines are simply the number given it in the table on page 175 which shows the name of the split, or locality ventilated by it; number of breasts ventilated; number of men working in the split; total number cubic feet of air in the return, and percentage of gas in the return.

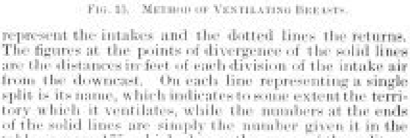


FIG. 15. METHOD OF VENTILATING BREASTS.

The positions of the overcasts or air-bridges by which the different splits cross each other are marked thus ‡‡ on Fig. 12.

(In the following description of the splits of air, references are made to Figs. 12 and 16):

The air entering the mine through No. 3 shaft is divided first at *E*, 100 feet from the downcast, one portion going in the east gangway and the other in the west gangway. This latter remains as one split and ventilates all the workings west of the shaft, going in through the breasts and gangway and returning through airway. The total length of this return airway is 9,800 feet with a sectional area of 84 square feet.

The air going in the east gangway is divided at No. 1 slope, *F*, 500 feet from the downcast, one portion going down the slope, the other going on in the east gangway as far as No. 3 tunnel, thence through No. 3 tunnel, where it ventilates all of No. 3 tunnel workings, after which it goes down to the slope west south dip gangway, ventilates this gangway and airway—going in the gangway and out the airway—and joins the return from the slope at *L*; passes thence up to the shaft level east airway through which it reaches the main return at *N*.

The air going down the slope is divided at the slope west north dip gangway *G*, one split going in this gangway and returning through the airway to join the return at *L*; the other split continues down the rock

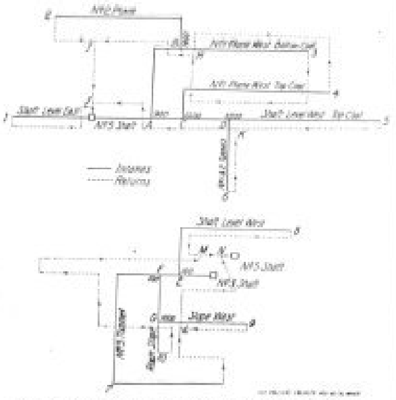


FIG. 16. PLAN OF DIVIDING INTAKE AIR FROM EACH SHAFT.

slope to the Baltimore vein gangway, which it ventilates, after which it passes through a rock outlet to the Hillman vein again and ventilates the workings east of the slope, after which it passes in through the shaft level east airway to the face and returns through the gangway and breasts, ventilating all the workings on the shaft level east gangway and joins the main return at *M*.

TABLE SHOWING VENTILATION, ETC.

	Number of Split.	Names of the Different Localities Ventilated by Each Split.	No. of Breasts Ventilated. Working.	Finished.	Total.	Number Men in Split. Day.	Night.	Total.	Total No. cu. ft. of air in return.	Percentage of Gas in Return.
No. 5 Shaft	1	Shaft level, east	28	25	53	72	10	82	37,500	2.6
	2	No. 2 Plane and east of No. 1 Plane	13	43	56	36	4	40	27,000	2.1
	3	No. 1 Plane, West Bottom Split, and Shaft level West Bottom Split	20	27	47	52	9	61	25,000	2.2
	4	Part of Shaft level West Top Split and No. 1 Plane, West Top Split	12	35	47	51	8	59	23,000	2.6
	5	Shaft level West Top Split	18	4	22	49	—	49	23,000	3.3
	6	Nos. 1 and 2 Tunnels	—	—	—	23	17	40	24,000	2.9
No. 3 Shaft	7	No. 3 Tunnel and Slope West South dip	5	4	9	30	6	36	27,000	4.0
	8	Shaft level West	36	71	107	74	—	74	32,000	1.9
	9	Slope West North dip	2	—	2	50	20	70	25,000	2.1
	10	Rock Slope and shaft level east	7	51	58	55	12	67	34,000	2.8
	*	Total			401			578	275,000	

Percentage of gas in main return of the whole mine at the fan, 2.5 per cent.
Total quantity of gas from mine, 6,875 cu. ft. per minute.

The air entering the mine through No. 5 shaft is divided first at the foot of the shaft, one portion going in the west gangway, the other in the east. This remains as one split and ventilates all the workings on the shaft level east gangway and a portion of the No. 1 plane east workings, going in through the gangway and breasts and returning through the airway. The length of this return airway is 5,300 feet with a sectional area of about 80 square feet.

The air going in the west gangway is divided at the foot of No. 1 plane, *A*, one portion going up the plane, the other in the gangway. This is subdivided twice, first at *C*, where a split enters the shaft level west top split workings, a part of which it ventilates and then passes up to No. 1 plane west top split workings, all of which it ventilates, after which it joins the return from the planes at *H*.

At *D* a split passes in through No. 1 tunnel, ventilates the workings of Nos. 1 and 2 tunnels and returns by rock outlets to the shaft level east top split airway and thus joins the main return from the west side at *K*. The air going in the west gangway beyond No. 1 tunnel (or the point *D*) remains as one split and ventilates the balance of the shaft level west top split workings and returns through the airway and joins the other return at *J* near the upcast. The length of this return airway is 7,400 feet with a sectional area of 72 square feet.

The air going up No. 1 plane (from the point *A*) is divided at No. 2 plane *B*, one split going up No. 2 plane and ventilating all of No. 2 plane workings, and then a part of No. 1 plane workings, after which it joins the returns from the planes at *I*; the other split ventilates first all the workings on No. 1 plane west bottom split gangway, then down to the shaft level west bottom split workings, all of which it ventilates, except the first panel of ten breasts (counting from shaft) which are ventilated by a portion of the air passing in from *A* towards *C*, and then passes through a hole to a top split breast, through which it passes up to the plane west airway and joins the return at *H*.

The water of this mine is collected finally in a sump (See *X*, Fig. 12), which was driven in coal in the shallow basin just to the north of the No. 5 shaft; from this it is pumped directly to the surface. From the workings the water naturally finds its way to the airways next the solid. Along these, in ditches made along the lower side, it runs toward the shaft and into the sump.

The water from the upper or Hillman vein workings is conveyed to the Baltimore vein workings through a pipe extending down No. 5 shaft from the Hillman to the Baltimore vein, and that from the slope workings is collected in a sump driven in rock at the foot of the rock slope, from which it is hoisted to the shaft level in a water car.

The pumping plant consists of one Jeanesville compound duplex plunger pump, manufactured by Jeanesville Iron Works, which has the greatest vertical lift of any pump in the anthracite region. The steam cylinders are 22″ and 36″x38″ and the plungers 9″ diameter with a 36″ stroke. The steam pipe is 6″ diameter, the tail pipe 10″ diameter and 80 feet long, with a vertical lift of 12 feet; the exhaust is 10″ diameter; the column pipe 10″ diameter with a vertical height of 1,040 feet. The column pipe has a water tight wood lining ⅞″ thick throughout its entire length, which reduces the internal diameter of the pipe to 8½″. The object of this lining is to protect the metal of the pipe from the corroding action of the water.

In order to accommodate the strength of the pipe to the varying pressures due to different depths, the metal is of different thicknesses, commencing with a thickness of 1½″ at the bottom of the shaft, and diminishing in thickness several times as it extends up the shaft.

The capacity of the pump at its normal speed of 40 strokes per minute is 24,000 gallons per hour.

This pump readily handles all the water of the mine at present by running two 10 hour shifts each week.

The pump is located near the foot of No. 5 shaft in a brick arched pump room (See *Y*, Fig. 12), 37 feet long, 14 feet wide and 9½ feet high in the center of arch. It is placed on stone piers, and the floor of the room is cemented.

The room was first excavated out of the coal in the pillar between the west side empty branch and the sump, and afterward walled and arched with a 17″ brick wall laid with cement mortar.

From the main pump room a heading extends back to the sump. This heading is also arched for a distance of 10 feet, and through this the tail pipe extends into the sump.

SURFACE PLANT.

The general arrangement of the surface plant is shown in Fig. 17. The No. 5 shaft engines are a pair of 28″x60″ direct acting hoisting engines, with cast iron grooved double-coned drum 8½ ft. end diameter., 14 ft. middle diameter and 19 ft. long. No. 3 shaft engines are 32″x60″ cylinders, and otherwise similar to No. 5 engines. Both are provided with Zehnder's patent steam brake, in addition to the ordinary hand brake. The ropes used on the drums are 1½″ Hazard wire rope, No. 5 shaft requiring 2,800 ft. and No. 3 shaft 2,500 ft. The normal hoisting capacity of each engine with a steam pressure of 75 lbs. is 70 cars per hour from No. 5 shaft and 80 cars per hour from No. 3 shaft.

The foundations of these hoisting engines are masses of stone work, each covering the entire area of the engine house, and are built up some 20 feet above the original level of the surface. They contain over 1,000 cubic yards of masonry each. A view of No. 5 engine foundation is shown in Fig. 6. The details of the standard cages in use are shown in Fig. 19.

Each fan is run by a 20″x48″ direct acting engine. The fans are provided with a Williams pressure recorder. The fan foundations contain about 525 cubic yards of masonry work each; the one is of concrete and the other of stone. The hoisting and ventilating machinery was built by the Vulcan Iron Works of Wilkes-Barre.

There are two separate steam plants. The Stirling boilers, located about 100 feet north of No. 5 engines, constitute one independent plant. The balance are located along High street about midway between the two shafts, and constitute the second plant. The whole steam plant consists of

	Total H.-P.
Eight cylinder boilers, 34″x30′, about 15 H.-P. each	120
Two Pollock boilers	100
Four National water-tube boilers, 125 H.-P. each	500
Two Stirling water-tube boilers, 125 H.-P. each	240
Total	960

(At No. 1 air-shaft are two Stirling water-tube boilers of 111 horse-power each which are not included in the above.)

Leading to No. 3 engines is a line of 8″ steam pipe from the National boilers, and to the No. 5 engines and also to the fans, are three independent lines from the different boilers. One of the lines leading to the fans is placed underground. These different lines are so connected at the fans and at the No. 5 engines that steam can be supplied to the fans and also to the No. 5 engines from either line desired by opening and closing the proper valves, which would be the work of but a few moments, so that should an accident happen breaking any line or all the lines but the one underground, the fans and also the No. 5 engine could still be supplied through this line.

In addition to these extra steam lines as precautionary measures, three lines of water pipe, two 4″ and one 8″ in diameter, are laid from a common valve to the head of No. 5 shaft, and two lines of 4″ pipe, also from a common valve, to the head of No. 3 shaft. Thus five streams of water could at a moment's notice be turned into the downcast by opening two valves, which are conveniently located, one near the head of each shaft, so that if from any cause both fans were disabled, the above means could be resorted to at once to produce a ventilating current that would at least make it possible for those inside the mine to get out before an explosive mixture would occur.

The breaker, one of the largest and best equipped in in the anthracite region, is 116 feet by 180 feet in size, and 145 feet high. In the foundation walls are some 3,500 cubic yards of masonry. Something over a million and a half feet of lumber was used in its construction.

The machinery is run by an 18″ x 36″ Vulcan engine and the cages in the breaker hoisting shaft are operated by a pair of 18″ x 30″ geared engines, geared 4 to 1 to a cast iron grooved drum 8 feet diameter by 20 inches long, also built by the Vulcan Iron Works. The principal machinery consists of 6 pairs of rolls as follows:—

Rolls:—
- 1 pair crushers,
- 1 pair main rolls,
- 2 pair prepared rolls,
- 2 pair chestnut rolls.

Elevators—
- 1 screening elevator,
- 1 pea and chestnut coal elevator,
- 1 bony coal elevator,
- 3 bony coal conveyors,
- 2 screening conveyors.

13 screens as follows:—
- 2 main screens, 8′ x 30′,
- 3 chestnut coal screens,
- 2 mud chestnut coal screens,
- 2 pentagon coal screens,
- 2 mud screens,
- 2 broken coal screens.

There are in all 1,481 feet of belting from 12″ to 24″ wide, the main belt is 159 feet long and 24 inches wide.

The breaker is heated throughout by steam. All screens, rolls, elevators, etc., are securely boxed in. Leading from each screen, thus enclosed, is a wooden pipe or airway of from 2 ft. to 4 ft. sectional area. These enter a common airway 5 ft. by 6ft. in size, which extends to a 14 ft. fan at the bottom of the breaker and thence horizontally to a 20 ft stack located about 100 ft. east of the breaker through which the current produced by the fan is discharged into the open air. At a point just outside the breaker the exhaust steam from the breaker fan and engine is discharged into this airway. The dust then comes from the screens through this airway where it is saturated by the steam and settles on the bottom of the airway from which it is removed from time to time as is necessary.

The loaded mine cars are run by gravity from the head of each shaft to the foot of the breaker shaft, where

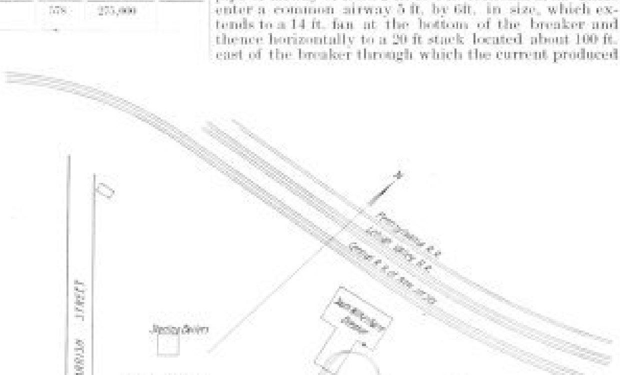


FIG. 17. PLAN OF SURFACE ARRANGEMENTS.

each loaded car is run on one of the two hoisting cages and hoisted to the top of the breaker, then run by gravity to the dump-shute. After a car has been dumped it is carried by means of a transfer rope and a transfer track around the breaker shaft and allowed to stand immediately back of the shaft on the same side that it was on when loaded. There is a sufficient fall between the transfer track and the breaker shaft to enable the empty car to "bump" the loaded car off the cage, and take the place of the next loaded car that comes up on the same side of the shaft. After the empty car leaves the cage at the foot of the breaker shaft, it runs, by gravity, to the foot of an empty car hoist, where it is hoisted to a sufficient elevation to carry it back to either shaft to be again lowered into the mines.

The mine car (See Fig. 18) is 8' 3¼" long, 4' 9½" wide at top, and 4' 2" wide at bottom, by 2' 1½" high for an iron bottom car, and 2' 0¾" for a wood bottom car. The iron bottom car contains 79 cu. ft., and the wood bottom car 75 cu. ft. when filled to the level of the top of the car, but as loaded in practice there are about 15 cu. ft. of topping, which makes the total load 94 and 90 cu. ft. respectively.

The average load, taken from a number of cars as they come from the shaft, is 6,337 lbs. The average yield of merchantable coal per car is 4,922 lbs. The refuse loaded in car, and dirt made in preparation is 1,415 lbs. or 22.3 per cent. of the total.

The percentage of the different sizes of coal as at present shipped from the colliery are:—

Lump	0.02
Broken	11.16
Egg	23.57
Stove	19.31
Chestnut	18.71
Pea	11.04
Buckwheat	14.29

The total shipments for each year and also the number of days worked since the completion of the breaker, are as follows:

	Tons.	Days worked.
1892	133,072	47
1893	258,368	186
1894	267,219	137
1895	312,188	162

The main steps in the preparation of the coal after it leaves the car at the dump shute are as follows: It first passes onto bars spaced 5" apart, all passing over these bars going to the lump coal shute; the balance passes onto bars spaced 2½", where a part goes through, the balance going to a platform where it is picked, and goes thence to the crushers, thence to the main rolls, and thence to the No. 1 or broken screens, from which come "egg" and "broken," which, after being picked, pass direct to the pockets. The balance from No. 1 screens goes thence to the main screens, from which "stove," "chestnut" and "egg" come, and after being picked go direct to the pockets. The balance from main screen goes by way of elevators to the chestnut screens, from which come "chestnut," "pea" and Nos. 1 and 2 "buckwheat" and pass direct to the pockets.

That going through the 2½" bars passes to the mud screens, from which come "egg" and "stove," which, after being picked, go direct to the pockets. Of the balance from the mud screens, that which is larger than egg goes to the prepared rolls, thence to the main screens, from which point its course is as has already been described. That which is smaller than stove goes to the mud chestnut screens, from which comes "chestnut" and "pea," which go direct to the pockets. All sizes smaller than "pea" go thence to a pentagon screen, from which come, ready for the pockets, Nos. 1 and 2 buckwheat. The balance passes directly over a shaker, from which some additional No. 2 "buckwheat" is obtained; the balance goes to the bank as dirt. That which goes through the 5" bars goes over a platform, where it is picked and goes thence to the main rolls and thence to the No. 1 or broken screen. From this point its course has already been described.

The culm piles are located about a mile west of the breaker, the culm being conveyed to them in cars by an eighty horse-power locomotive.

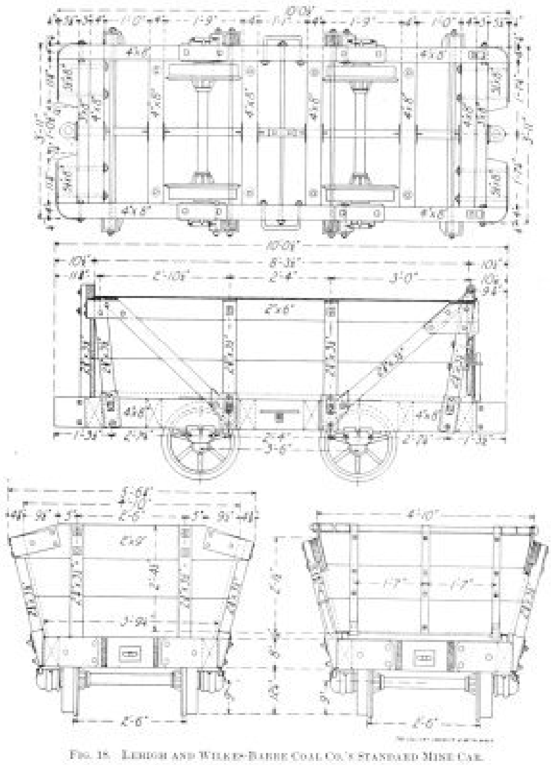


FIG. 18. LEHIGH AND WILKES-BARRE COAL CO.'S STANDARD MINE CAR.

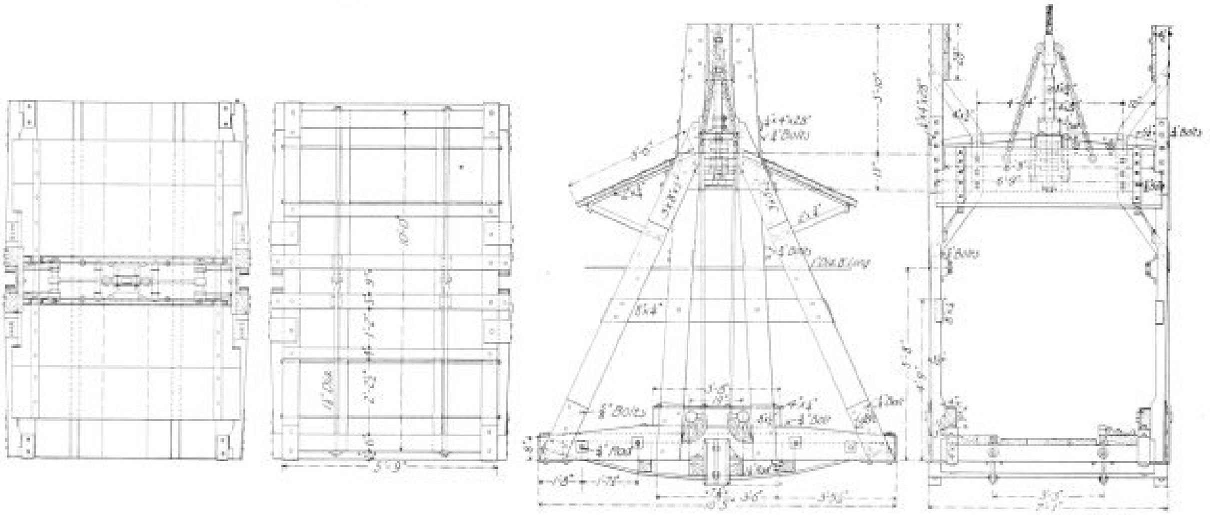


FIG. 19. LEHIGH AND WILKES-BARRE COAL CO.'S STANDARD SHAFT CAGE.

Telephones in the Mines.

Within the past year an interesting departure has been made in the method of communicating between the inside workings of coal mines and the out-side world.

For a number of years experiments were being made with telephones especially constructed to meet the requirements, and while some were in a measure successful, none were of a practical character. The expiration of the Blake patent gave additional impetus to the experimentation, and particular attention was given to improving and protecting the adjustment.

While the experiments have only been partially successful, the results obtained have contributed largely toward solving the problem of underground telephony. The Lehigh Valley Coal Co., has installed a number of telephones in their mines and the results are both satisfactory and gratifying.

The principal difficulty encountered arose from the corrosive action of the atmosphere of the mines upon the delicate mechanism of the instrument. The diaphrams rusted quickly and became useless. Again the dampness caused alternate warping and swelling to the boxes, throwing everything "*out of line*."

Col. D. P. Brown, Division Superintendent of the Lehigh Company, has arrived at a method which enables him to prevent the damp atmosphere from reaching the instrument. His plan is to locate the telephone in as dry a place as possible, generally in the pump house, or at a point near the intake. He uses No. 12 phosphor bronze wire strung upon porcelain insulators screwed to the timbers in the rib. He splits the air causing a current of fresh dry air to circulate about the closets enclosing the telephones. While it is impossible to prevent entirely the moist atmosphere from reaching the instruments, yet by this method and with superior transmitters success has been at last attained.

The great value of the telephone in mining operations was demonstrated at the fire which recently occurred at the Packer No. 4 colliery in the workings on the 5th lift. The fire broke out at night and in a few moments after its discovery, a connection was made to a grounded circuit outside and communication established between the superintendent's office at Lost Creek, 1½ miles distant, and a point within 200 feet of the fire. The length of the underground line was over 1,800 feet. So efficient was this service that orders were issued to place telephones in all of the company's mines. The Primrose colliery, near Mahanoy City, is now being equipped with a telephone system which when completed will enable communication to be carried on, not only with the colliery office on the surface, but also with the office of Superintendent John A. Grant at Lost Creek, and the office of General Superintendent Lathrop at Wilkes-Barre.

Underground telephone systems have been installed at the Brookside colliery of the Philadelphia and Reading Coal & Iron Co.; the Williamstown colliery of the Summit Branch Coal Co.; the William Penn colliery; the collieries of the Susquehanna Coal Co., at Nanticoke, and the Lytle colliery near Minersville. At all these operations the system is in successful operation. As success has been attained and at an extremely reasonable cost, the general introduction of this method of communication at all the collieries may be looked for in a short time.

Tennessee's Coal Production in 1895.

Mr. F. P. Clute, Commissioner of Labor, Statistics and Mines of Tennessee, sends us the following table of the coal production of that State in 1895:

	Short Tons.
Anderson county	345,291
Claiborne "	147,122
Campbell "	323,289
Grundy "	446,786
Hamilton "	166,889
Marion "	302,298
Morgan "	58,862
Putnam "	7,720
Roane "	120,423
Rhea "	140,852
Scott "	112,178
White "	125,334
Total	2,304,720

To which must be added 15,000 tons as the estimated production of small mines whose output has not been reported, making a grand total of 2,319,720 short tons.

The earth's magnetism, although practically useless as a great power for driving mills, has one of its uses in operating a mariner's compass, which, next to Columbus, was the means of discovering America. This illustrates that although several of the natural forces are of little service for driving machinery, yet in other ways they may become of utmost importance.—*Electric Power.*

PROSPECTING FOR GOLD.

GOLD PLACERS; HOW THEY ARE WORKED.

Theories of the Origin of Gold Sands and the History and Distribution of Gold Placer Deposits Throughout the World.

Written for THE COLLIERY ENGINEER AND METAL MINER by Prof. Arthur Lakes.

(Continued from February.)

Gold was known to exist in Brazil in the beds of streams, and Indians in early days made their fish-hooks of it. The gold placers were first discovered in 1577. The gold was first found in Rio das Mortes, or River of Death, so named from the bloody encounters between the gold hunters, who it is said "met and set upon each other like famished tigers, impelled by the accursed hunger for gold." Along this river are abundant evidences of their extensive search for gold. The banks are everywhere furrowed and the vegetable mould has been entirely removed. Nothing remains but the

SOUTH AMERICA.
Dots Show Location of Gold Deposits (After Locke).

red dirt cut into squares by channels divided by narrow ridges. These channels were used for washing gravel and were cut on an inclined plane. The water was introduced at the head of them, the dirt was then thrown in, and the lighter particles of clay were washed away while the gold remained behind. (The appearance of these furrowed banks reminds one of the furrowed appearance on a larger scale of the Alma placer banks as pictured in a former issue of THE COLLIERY ENGINEER AND METAL MINER.)

The first placers were called "cata." The surface dirt which contained gold was mined until the "cascallo" or cement gravel was reached. This was broken up by pickaxes, brought to the river and washed. The first improvement was (as in early days in California) to conduct the water to the ground and wash the gravel on the spot. These works were called "lavras," and hundreds of them were to be seen on the banks of the river. In some districts water wheels were used to assist in the drainage of the excavations, but were found to be so unmanageable that they were thrown aside and negroes were employed to pack off the gravel and rubbish on their heads in small casks. From 1691 to 1875 the gold production of Brazil amounted to 2,281,510 pounds Troy.

Chili has golden sands and deposits which do not appear to have been formed by the decomposition of regular veins. They are found in decomposed granite and red clay near Valparaiso. Similar deposits occur along the flanks of the Andes. Recent attempts by Americans to hydraulic the deposits have not been successful—yield of gold very small and water scarce.

In Peru gold was gathered by the Incas. Under Spanish rule $33,000,000 was extracted from the mines and washings of Caravaya. The work was put an end to by a massacre by the Indians.

In Venezuela large placers have recently been discovered. United States of Colombia contained the famous El Dorado visited by Sir Walter Raleigh in 1517 and by the buccaneers in the seventeenth century. It was situated in the province of Castilla del Oro. The Cana mines of this district, worked by slaves, yielded largely in the seventeenth century. The mines of Choco west of the Andes are among the most productive in the west of South America. They contain platinum as well as gold.

Cortez's exploring parties in Mexico obtained gold from the beds of rivers several hundred miles from the capital. Gold cast into bars or in dust was a regular export. The gold from Mexico now is mostly from quartz leads. The gambusinos or native prospectors, however, wash with the batea in local placers. Rivers supposed to carry bonanzas in their beds have been turned from their courses, but without success. Prospectors obtain some gold from crevices in bed rock which they reach with shafts.

Australia's most important gold fields are in the colonies of Victoria and New South Wales. Queensland and South Australia also contain gold alluvions.

The gold product of Victoria in 1880 was 529,129 ounces, 299,926 of which came from placers. Although the old placers have been worked extensively and exhausted in many cases, new areas have been opened and worked by improved means. From its discovery in 1851 to 1880 gold amounted to £198,196,206, mining operations extending over 1235 square miles.

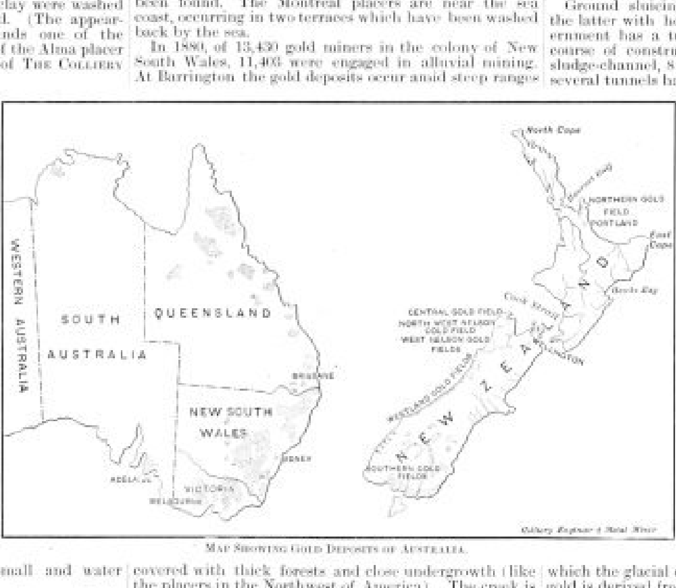
Ararat district contains large deposits from the Upper Pliocene of marine origin, but no gold is found in these. The gold occurs in the Lower Pliocene of fresh water origin. We may mark here that not a single quartz vein occurs in this district from which the gold could have been derived. The depth of deposits is 90 to 100 feet, resting upon granite and mined for a length of two miles and a width of 1,200 feet. The lead, owing to the presence of saline water, is supposed to be a depression in an old sea bottom.

In the Ballarat fields are four clearly defined epochs of gold drift, known as oldest, older, recent and most recent. The "oldest" is a deposit made before the time at which the channels were eroded to their present depths. The "older" is the deposit intervening between the lava flows. The "recent" are those following immediately the uppermost lava flows. The "most recent" are those in recently eroded gullies. (These lava-covered placers are very like the lava covered deep beds of California.) There are three great lead systems—the Southern, Western and Eastern. The Southern has been explored extensively, the Western is looked on as the future hope of Ballarat, and the Eastern is but little known.

In Beechworth district the placer material is derived from Silurian strata, not from granite (in this respect reminding us of the Homestake gold mines in the Black Hills which are worked in Cambro Silurian or Pottsdam conglomerate). Mining is by ground sluicing on a grand scale. The thickness of gravel is 30 to 50 feet, mostly in creeks and on the banks. Sandhurst district was worked since 1853 on a cement deposit of Pliocene. The gravel is shallow—the deepest shafts 35 to 55 feet. The gold-bearing districts of New South Wales are the richest and largest in Australia. The fields extend the length of the colony, with breadth of 200 miles. Immense tracts in the interior are still unprospected. Up to 1871 placers alone were worked, gold quartz mining being, as usual in those early days, neglected. Sixteen thousand men were then at work. From 1851 to 1871 the product was £26,457,160. The gold regions are but two days' journey from the capital.

In several of the districts water is scarce, yet in places, as at Tenora, a large amount of very coarse gold has been found. The Montreal placers are near the sea coast, occurring in two terraces which have been washed back by the sea.

In 1880, of 13,430 gold miners in the colony of New South Wales, 11,403 were engaged in alluvial mining. At Barrington the gold deposits occur amid steep ranges covered with thick forests and close undergrowth (like the placers in the Northwest of America). The creek is worked for gold, but the water supply is uncertain and in summer the creek ceases to flow. The Kiandra field is on the table land of Maneero, 5,000 feet above sea level, close to the highest mountain of the colony. Near Mt. Tabletop the alluvions have been covered with basalt and so far but little exploited. The sluicing operations toward Mt. Tabletop have been compared to the gravel deposits of Placerville, California.



Map Showing Gold Deposits of Australia.

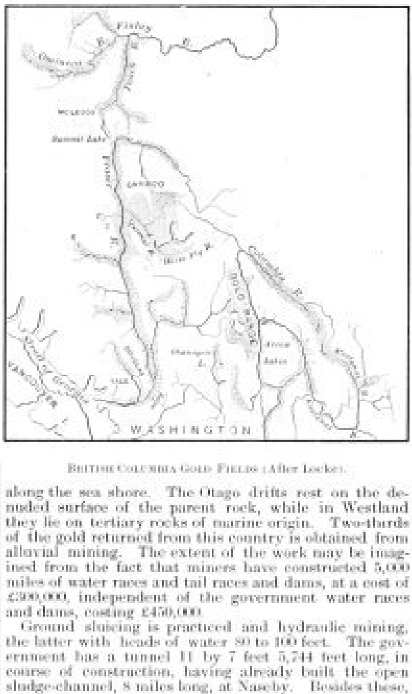
In the Tallawang field the gold occurs in one of the most ancient alluvial deposits in the world, belonging to the Tertiary, and in conglomerates of the coal measures gold has been found. (This suggests that in Colorado and elsewhere we pay some attention to the old consolidated conglomerates of different past periods as well as to the modern alluvial deposits of more recent date.)

At Clough's Gully the conglomerate is worked, yielding from 1 to 15 pennyweights per ton, and nuggets of 5 ounces are occasionally found. (In this connection we may observe that gold in small amounts has been found in the tertiary sandstones and conglomerates near Colorado Springs.)

The colony of Queensland has 3,100 square miles of gold-bearing gravel worked in 1876. The fields occur on both sides of the dividing range, separating the eastern and western waters, and on the spurs of the range forming the watershed to the Gulf of Carpentaria. (Placers in similar relations to the Front range occur in Colorado.)

In South Australia gold is found in every part of the colony in deposits of limited size. In Spike's Gully a drift 20 to 100 feet deep consists of quartz pebbles, boulders and rusty conglomerate, and the gold is waterworn.

Gold was discovered in New Zealand in 1842. The alluvial deposits are chiefly in the south island, where operations are carried on over an area of 20,000 square miles. The detritus is in beds of rivers, on large deposits of gravel 300 to 500 feet deep, and on the sands



British Columbia Gold Fields (After Locke).

along the sea shore. The Otago drifts rest on the denuded surface of the parent rock, while in Westland they lie on tertiary rocks of marine origin. Two-thirds of the gold returned from this country is obtained from alluvial mining. The extent of the work may be imagined from the fact that miners have constructed 5,000 miles of water races and tail races and dams, at a cost of £300,000, independent of the government water races and dams, costing £450,000.

Ground sluicing is practiced and hydraulic mining, the latter with heads of water 80 to 100 feet. The government has a tunnel 11 by 7 feet 5,744 feet long, in course of construction, having already built the open sludge-channel, 8 miles long, at Naseby. Besides these, several tunnels have been built by private individuals.

In the river Clutha dredging machines are used, and north of Charleston the sea beach sands containing gold are worked by Shetlanders. At Tinkus 40 sluice heads with 130 feet head, conducted through 4,500 feet of iron piping, are used to hydraulic the gravel. The depth of deposit is 30 feet. In Tapir district gold is found in considerable quantities *in decomposed soil on the slopes of the hills*. It is usually flaky and not at all waterworn. (This is very like the occurrence of gold in so-called placers on Mineral Hill, near Cripple Creek, Colorado, where the gold occurs in soil and in a gravel of small, angular pebbles to a depth of 10 feet on the hillside. The deposits bear little evidence of transportation by water and the gold is flaky and not waterworn. It was evidently derived from decomposition of float, etc., very close to the deposits.)

In the conglomerate formation the gold is caught in the brown sandstone bottom over which the conglomerate lies. In the glacial drifts extensive claims have been worked and large quantities of gold obtained (as in Colorado). These deposits derive their gold from the slates of which the glacial drifts are composed. (In Colorado the gold is derived from all kinds of crystalline rocks, principally granites, schists and porphyries).

The "black sand beaches" on the sea coast are composed of crystals of magnetic iron ore (as in California), which are found disseminated through the chloritic schist. In places the ground is "spotted" and the gold unevenly distributed.

In Canada, North America, the gold is derived from

(Continued on page 182.)

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THE MINERAL RESOURCES OF VARIOUS NATIONS.

WE have before us the "First Annual General Report upon the Mineral Industry of the United Kingdom of Great Britain and Ireland."

Being the first Annual Report, it is commendable as such, for its collection of facts that are intended to furnish a basis for a "Comparison of the Mining Industry of Great Britain with other Foreign Countries."

The mineral resources of other nations shown in tables in this report teach lessons of great value. For example, we learn that a high civilization and good government are necessary for the development of the mineral resources of any country, and therefore we find the Chinese in possession of the richest mineral treasures of any people on the earth, and yet they do not develop them.

On page 59 of the report we read:

"The mineral wealth of China is enormous. In addition to important coal fields, it possesses numerous workings for metallic ores. The province of Yunnan in the south of the empire seems to be specially favored with regard to metalliferous wealth, for mines of gold, silver, copper, iron, lead and tin are worked there; whilst jade and precious stones are found in the beds of rivers. Brine springs yield salt, and natural gas discovered in boring for salt is used in evaporating the brine.

"The peninsula of Corea has likewise been richly endowed with minerals by nature, and gold is worked in various parts of the country, and though the methods of extraction adopted are primitive, the output is by no means inconsiderable; anthracite and the ores of lead and iron could be wrought by an energetic population, to say nothing of the other minerals."

The decline in the copper mining of the British Isles is the result of the ores of poor quality having to compete with those of a richer yield, and therefore British capital is transferred to foreign mines, so that here we have conditions in industry and trade the opposite of those found in China. From the Report we learn that the output of metallic copper from the British mines in 1860 was 236,000 tons, and in 1894 it had fallen to 5,994 tons; or in 34 years the output had fallen to $\frac{1}{40}$th of its former value.

The phosphate industry of the British Isles is dying a lingering death. The phosphates of Florida are of better quality, and for the price, the British farmer is finding them a better paying investment. Here, then, is a nation, ready to compete with the world in the development of her resources, beaten at home, while the Chinese, having the best resources in the world, are lacking in the enterprise to open them out.

Speaking of Arabia, the report says:

"The Arab is not a miner by nature, and there is little or no working for minerals on the great Arabian peninsula. In days gone by, according to Burton, gold mines were worked in the land of Midian."

Contrast this case again with that of England: Here their principal supply is the Cleveland ore, that is an earthy carbonate, and only yielding 30 per cent. of metallic iron, and in addition to which they have the brown hematite confined to a restricted area in Yorkshire and Lancashire yielding from 50 to 60 per cent. of metallic iron; and the black band ironstone of Scotland that gives a moderate yield both of ore and metal, and yet by enterprise this people according to the report have to import large supplies of iron ore from abroad, for, says the report:

"Algeria is rich in iron, and two-thirds of the value of its total mineral output are due to the ores of this metal. The principal mines are those of the Moktael-hadid Company, which works magnetic iron ore in the department of Constantine, and manganiferous red hematite in the department of Oran. The whole of this ore is exported, England taking a far larger share than any other country."

No nation in Europe has smaller mineral resources than Italy, and, notwithstanding the fertility of her soil and the great industry of her people, having no coal to smelt her iron ores, that are abundant, and develop manufactures, she does not take rank as a rich nation, for she is only an exporter of zinc, marble and sulphur.

Coal mines make nations richer than do gold mines, and the nations that most actively compete with each other are those that develop their coal resources most, as can be seen by the following output in tons, taken from the report under consideration, and given in *millions* of metric tons, for the year 1894.

The following is the coal production for 1894, in millions of metric tons, of the most powerful nations of the earth; the names are set according to the magnitudes of the outputs:

	Tons.		Tons.
Great Britain	190,000,000	France	28,000,000
United States	162,000,000	Austria-Hungary..	15,000,000
German Empire	98,000,000	Russia	9,000,000

The iron ore productions for 1894, in millions of metric tons, of the most powerful nations of the earth are as follows, the names are set according to the magnitudes of the outputs:

	Tons.		Tons.
United States	20,000,000	France	1,000,000
Great Britain	13,000,000	Austria-Hungary	1,000,000
German Empire	8,000,000	Italy	0.100,000
Russia	4,000,000		

Altogether, the facts furnished by the report indicate that the United States in the immediate future will be the greatest mining and manufacturing nation on earth, because she has the mineral resources and the energy and high degree of civilization necessary for their utilization.

ILLINOIS COAL INDUSTRY.

HON. GEORGE A. SCHILLING, Secretary of the State Bureau of Labor Statistics of Illinois, has completed the compilation of the report of the coal industry of that State for 1895. A study of the summary of Mr. Schilling's report, as given in the following table, will prove of interest. The comparisons of the statistics for the years 1894 and 1895 are very complete:

	1894	1895
Number counties mining coal	56	54
Number mines and openings	836	847
Number shipping mines	319	319
Number mines in local trade	517	528
Number tons coal mined, all grades	17,113,576	17,735,864
Number tons lump coal mined	13,865,284	14,045,962
Number tons other grade of coal	3,248,292	3,689,902
Number of tons nut coal included in other grades	479,595	897,912
Number acres worked out (estimated)	2,818.01	2,950.69
Number employes, all kinds	38,477	38,630
Number miners	31,595	31,515
Number other employes, including boys	6,882	7,115
Number boys over 14 under ground	701	811
Number employes under ground	32,046	34,648
Number employes above ground	6,431	3,982
Average number of days of active operation, shipping mines	181.1	182.2
Aggregate home product	$15,282,111	$14,239,157
Aggregate home value lump coal	$13,998,788	$13,090,836
Aggregate value other grades of coal	$1,283,331	$1,148,321
Average value lump coal at mines	$1.0086	$0.932
Average value other grades at mines	$0.395	$0.309
Average price for hand mining (the year)	$0.761	$0.573
Average price for hand mining (summer)	$0.6435	$0.516
Average price hand mining (winter)	$0.6847	$0.596
Number tons lump coal mined by hand	7,368,860	7,868,000
Number tons mined by hand, day wages	1,290,860	1,100,540
Number tons mined by hand, gross weight	2,727,331	2,934,998
Number mining machines in use	296	322
Number tons coal, all grades, machine mined	3,396,139	3,531,436
Number tons lump coal, machine mined	2,496,793	2,409,904
Number tons, other grades, machine mined	798,781	824,235
Number kegs powder used	758,383	824,998
Number men killed	72	75
Number wives made widows	41	42
Number children left fatherless	114	111
Number men injured, losing time	521	605
Number tons coal mined to each life lost	237,689	236,478
Number tons coal mined to each man injured	32,847	29,312
Number employes to each life lost	534	515
Number employes for each man injured	74	64
Number of mines opened and old ones reopened	156	115
Number mines closed or abandoned	108	78

STATE GEOLOGICAL SURVEYS.

UNFORTUNATELY the value of State geological surveys is realized by comparatively few citizens not interested in the development of the mineral resources in their respective States. As a result such surveys are accorded either very lukewarm support or very decided opposition by many citizens and members of legislative bodies. A number of the States of the Union have now in progress such surveys, and Pennsylvania (the richest mining State) has practically closed hers as *finished*. The value of a first-class, up-to-date, geological survey of a State to its material development cannot be estimated. Such a survey determines the presence or absence of minerals, and makes such facts public. If the minerals are present, the State is enriched by their development and utilization. If absent, the State is benefited by the saving of the capital and labor of its citizens who are informed of the futility of spending time and money prospecting for an absent mineral.

A geological survey may be either very general in its character or may be very detailed. The latter is the better, and the money expended in procuring it will be returned, in an indirect manner, many time over. It is a grave mistake for any State to follow the example of Pennsylvania in terminating its geological survey. While it is true that Pennsylvania's geological survey has pretty thoroughly covered the State, it has not completed the work. In fact the work will never be completed until the last ton of mineral available in the State has been mined. Thanks to conscientious work on the part of the officials of the survey and the assistance of the mine owners and the mining engineers of the State, the one hundred and twenty volumes of Geological Survey Reports of Pennsylvania are in excellent shape, *up to the date of issue* of each. But in some instances they are "back numbers." The actual opening up of the minerals with pick and drill, has in very many instances proven that abnormal features in the strata, which could not be determined on the surface, have changed the conditions so that the approximations of the survey were incorrect. This is in no wise an adverse criticism on the work of the survey. There are fully as many instances in which the approximations have been proven remarkably exact. To make Pennsylvania's survey of permanent value and use, the records made by pick and drill should be collected by the State, and a permanent geological survey force should be maintained to issue an annual report, which would note all newly discovered geological features and correct all mistakes made in previous reports. Such a force would not entail any great expense on the State. A State Geologist with a corps of three or four young men as assistants would be force enough to keep Pennsylvania's geological survey reports up to date. In Prof. Peter Leslie the State has a citizen eminently qualified for the work, and one to whom the Commonwealth owes a debt that it will be difficult to pay. He was at the head of the Second Geological Survey and is familiar with every detail of the work. Besides, his personal sacrifices of time and his own means, in the interest of the work, when State funds were not available, make it but an act of justice that the State of Pennsylvania should install him in such an office. Every State now having a geological survey in progress, will be greatly benefited if it makes the office of State Geologist a permanent one, and thus keeps up a system of annual reports after the main work of surveys now in operation is completed.

Naturally, the appointment of a State Geologist must not be given to a politician. The men qualified for such positions are not active in politics. Therefore, the office should be an appointive one.

Book Review.

Shop Kinks and Machine Shop Chat. A series of over Five Hundred Practical Paragraphs in familiar language, showing special ways of doing work better, more cheaply and more rapidly than usual. By Robert Grimshaw, M. E., etc. Octavo cloth. 293 pages. 222 illustrations. Published by Norman W. Henley & Co., New York. Price $2.50. This is Mr. Grimshaw's latest production, and it is fully up to the practical standard of his other works. It is written in the author's well known and unique style, which presents technical facts in such language as to amuse as well as instruct the reader. In fact Mr. Grimshaw might be aptly called the Mark Twain of technical writers. Technical subjects as a rule are treated in a manner that makes their study a task of more or less magnitude, depending on the interest of the student. Mr. Grimshaw's method of treating such subjects makes them attractive and pleasurable. The volume before us, with its five hundred hints, must contain a large number of great value to every shop manager, foreman, machinist and engine driver. It is not an exaggeration to say that the man connected with machinery who reads this book will strike at least one idea that will be worth many times its price to him. It would pay the manager of every machine shop in the country to get a copy of this work and also to present a copy to each of his foremen. It don't take much of a "kink" to save $2.50 on any ordinary job.

Proceedings of the Alabama Industrial and Scientific Society, Vol. V, 1895. Published by the Society, University Post Office, Alabama. This pamphlet contains in addition to the official addresses, reports, etc., the following papers: Utilization of By-Products from Coke Oven, by J. A. Montgomery; Mobile Point Alabama's Deep Water Harbor, by G. D. Fitzhugh; Alabama Barite or Heavy Spar, by Henry McCalley; The Pig Iron Market, Its Extent and How to Improve It, by James Bowron; Value of Raw Materials in Iron Making, by Prof. W. B. Phillips; Alabama's Resources for the Manufacture of Portland Cement, by Eugene A. Smith.

Seventh Biennial Report of the State Mine Inspectors of Iowa. For the two years ending June 30, 1895. In this State there are three Inspection Districts, under the supervision of, Mr. James A. Campbell, 1st District; Mr. J. W. Miller, 2nd District, and Mr. Morgan G. Thomas, 3rd District. The reports furnish few numerical statements and we are not therefore able to give the mortality and injury arising from different and prevailing causes in percentages, so as to contrast Iowa mining with that of other States. We learn, however, that the output of coal for the year ending the 30th of June, 1895, was a little over three millions of tons, and that the number of persons employed in the mines and on the surface for that output was 10,992.

We have by counting out of a great number of small tables found the following facts: Out of 320 collieries artificial ventilation is produced as follows:

Steam jet, 4; furnace, 218; fan, 98. Classifying the modes of working under two heads, we have: Room and pillar, 221; longwall, 99.

The Journal of the Iron and Steel Institute of Great Britain, 1895, Part II. This is the forty-eighth volume of the transactions of this great engineering society, and it is edited by Mr. Bennett H. Brough, secretary. It is an octavo volume of 658 pages, bound in cloth, and published for the Institute by E. & F. N. Spon, London and New York. Besides a large number of valuable papers by members of the Institute and discussions on the same, it contains in Section II, "Notes on the Progress of the Home and Foreign Iron and Steel Industries," which are abstracts from the latest and best literature on the subjects directly and indirectly connected with the iron and steel industry. These abstracts with references to their source have been made by Edwin J. Ball, Ph. D., and the secretary.

The Origin and Rationale of Colliery Explosions, *Founded upon an Examination of the Explosions at the Timsbury, Albion, Malago Vale and Llanerch Collieries, and upon the Principal Phenomena at over a score of other British Collieries.* By Donald M. D. Stuart, F. G. S., Mining and Civil Engineer, author of "Coal Dust an Explosive Agent." Quarto, Cloth. Published by John Wright & Co., Bristol, Eng.; Simpkin, Marshall, Hamilton, Kent & Co., London; Hirschfeld Bros., New York. Price, $3.00. The writer very ably maintains his theory of the cause of explosions in what he calls non-gaseous mines, and he attributes to coal dust more than to fire damp, the origin of nearly all the explosions in mines. One cannot read a page of this book without being impressed with the conviction that the writer is intensely in earnest, and therefore his book is worth reading; for, whether we can accept the dictum or not, that there is or can be a seam of coal that in course of working gives off *no gas*, and the dust of which when heated gives off *much gas*, or the other conclusion of the writer that the heating of the dust by flame separates pure hydrogen entirely disassociated with carbon, we still learn a great deal from the writer's collection and arrangement of facts. He shows clearly that at the explorations of the workings of the Timsbury and Camerton mines immediately after the explosions in the "*non-gaseous*" workings, it was evident that the explosive force was repeated at several points in succession, or in short that instead of a single explosion in both these and other cases that he refers to, the blasts were of a multiple character. This conclusion we can fully endorse by experience, and the fact of the multiple character of explosions has been known for more than half a century. Mr. Stuart finds that there were no less than 18 centres of explosions located in the Timsbury workings after the disaster there, and in every one of them the force had acted destructively in opposite directions; and further, the coked carbon was found to adhere to the roof and sides in the regions of the hottest flames. He concludes with good reason that the gas given off by the heated dust was in excess of the oxygen required for its combustion, and therefore along certain lines the gas traveled with the swift current until fresh supplies of oxygen quickened it at certain points into a fresh explosive mixture. These are the claims among others of no less importance that the author tries to establish, and whether his conclusions are right or not, the book is of great value, being ably written, and being also the best presentation of the claims of the coal dust theory we have seen.

Hand Books for Mining Students and Colliery Managers, Part II. *Boilers and Fittings—Heat and Steam—Steam and Other Engines.* Octavo. Cloth. 51 Pages. Price, 1s. (24 cents.) Published by *The Science and Art of Mining*, Wigan, England. This little volume treats on Steam Boilers, the Properties of Steam, and the Powers and Modes of Action of Different Steam Engines. The style of the book is that of a catechism. The answers to the questions are correct in principle and so simply rendered that like all other books of this character, it will prove an invaluable aid to progress, when in the hands of men who are striving to advance.

The Natural Philosophy of a Ventilating Regulator, By H. W. Halbaum. Octavo, paper covered, price, post paid, 1s. 1d. (27 cents). Published by Thos. Wall & Sons, Wigan, England. This is a small treatise that aims at showing that former writers were wrong in their mathematical expressions for calculating the velocities of air currents through the regulators in the air passages of mines. From the style and confidence of the writer we are led to conclude that Mr. Halbaum is a young man of small experience yet of considerable ability, and for that reason he appears to require a little regulating to correct his ideas of respect for such writers as Mr. Pamely. Why the latter gentleman should be singled out for attack we are at a loss to understand. In the first place it is true that some carelessness has been practiced by writers on mine ventilation, in making equations for regulator velocities, but Mr. Pamely appears to be only one of the number, and as he is a man of considerable weight, the writer of the pamphlet goes boldly for him. Under these circumstances the author cannot wonder if we remind him of two things that concern us.

First:—In our issue of November last we gave on page 92 of The Colliery Engineer and Metal Miner the correct expression for the velocities of air currents through regulators, and that is the month in which Mr. Halbaum printed the treatise under consideration.

Second:—We began in the last September issue of The Colliery Engineer and Metal Miner, a series of articles on the ventilating fan, in which it was shown that it was altogether an error to calculate the velocities of air currents entering ventilating fans, by taking the equivalent pressure that balances the mine resistance, to find the effective pressure for the *fan's* not the *mine's* equivalent orifice. Now here is a common mistake just as great as that of the usual formula for calculating regulator velocities, and yet on page 46 of Mr. Halbaum's treatise he says, "And, indeed, to refuse to grant its truth as an abstract statement would be to call in question the whole theory of the conservation of energy." Mr. Halbaum should have detected the misapplications of M. Murgue's theory of the equivalent orifice.

Lidgerwood Cableways for the Panama Canal.

Spencer Miller, M. E., engineer of the department of hoisting and conveying machinery of the Lidgerwood Manufacturing Company, New York City, who recently went abroad in the interests of that company, has just closed a contract with the Compagnie Nouvelle Du Canal De Panama at Paris, for seven Lidgerwood cableways, to be used on the Panama Canal. This company is one which has recently been formed to complete the great Panama canal, and the seven cableways will be used exclusively for earth excavating. They will be equipped with all the latest improvements, including the patent aerial dump, which is such an important feature of these machines, the apparatus throughout being similar in construction to the twenty Lidgerwood cableways used on the Chicago Main Drainage Canal, except that the Panama cableways will have fixed towers and anchorages. The spans will range from 250 to 300 feet. This order was not placed until after a most careful and extended investigation had been made of the various apparatus available for canal excavating purposes. Engineers were sent by the Compagnie Nouvelle Du Canal De Panama from Paris to examine the Lidgerwood cableways and other excavating machinery in use at Chicago on the canal there building. The result of their investigation was a most flattering report in favor of the Lidgerwood cableways, and the negotiations then begun have resulted in the large order secured by Mr. Miller. This is one of the largest single orders for cableways of any description ever received by any concern in this country from abroad, and points to a world-wide appreciation of the merits of the Lidgerwood cableway that fully justifies the claims advanced by the manufacturers that it is the most perfect, most economical and efficient apparatus of the kind ever devised.

The Tennessee Centennial and Industrial Exposition.

Tennessee proposes to celebrate the One Hundredth Anniversary of her admission to the Union by holding at Nashville an exposition, beginning Sept. 1, 1896, and continuing 100 days.

The Tennessee Centennial and International Exposition has been organized and will be carried out on a grand scale and in a manner worthy not only of the state of Tennessee, but of the whole country. While it is the purpose to emphasize the natural resources of Tennessee, yet we invite and desire competition from all quarters. It will be a rare opportunity for those who may wish to advertise to the public at large their ores, minerals, coals, clays, marbles, building stones and kindred material, as well as machinery and appliances for mining, quarrying and finishing the same.

No charge will be made for space in any of the buildings of the Tennessee Centennial and International Exposition, but exhibitors will be required to make a small deposit at the time their exhibits are accepted, as a pledge of good faith that the display will be ready for inspection September 1, 1896. If it is ready then, the deposit will be promptly returned. The above applies to those who make exhibits for profit; no others are required to make such deposits.

We trust that you will see fit to avail yourself of the opportunity presented and supply us with a generous exhibit.

Inquiries for additional information will be promptly and cheerfully answered, if addressed to Paul M. Jones, Secretary, Nashville, Tenn.

A Most Effective and Inexpensive Pump.

We desire to call the attention of our readers to the Vanduzen Steam Jet Pumps (see advertisement in another column). These pumps are of unique simple design, and so constructed that when placed in position for regular duty, they cannot retain water while not at work, and hence cannot freeze up in the coldest weather. Being made of brass, they will not crack or break because of extremes of temperature, and will stand greater strain and will not rust. They will always be found ready for work and need no watching nor constant looking after; when put in place it is only necessary to turn on steam and it starts to work, and turning off steam will stop it. It is used for many different purposes; in wells, pits, quarries, mines, river and lake sides, tube wells, in tanneries, mills, factories, on steamships, tugs, ferry boats, and so we might name numerous other uses for this excellent pump. As they operate in conformity to the law of nature with steam as the active agent, it is an absolutely reliable pump at all times. Thousands of them are in daily use, not only in the United States, but in at least twelve foreign countries, Australia, Hawaii, Japan, India, South Africa, Cuba, West Indies, and in Mexico, and Central and South American countries, and everywhere they give full and entire satisfaction. The price is so low, and the setting up is so simple that any one in need of a simple steam pump should certainly secure one or two as the case may require, at once. The cost ranges from $7 for the smaller size, up to $75 for the largest size, which will elevate from 10,000 to 15,000 gallons of water per hour to any height not exceeding 50 feet, vertically measured. Where the height exceeds 50 feet but not over 100 feet, two pumps are used, one above the other. We can recommend these pumps, and the manufacturers, the E. W. Vanduzen Co., Cincinnati, Ohio, will take pleasure in sending price and illustrated catalogue free.

Proposals Wanted from Engineers.

Sealed proposals will be received by the Council of Oakmont Borough, Pa., for the following work:

1st. For a complete profile and grade plan of all streets and alleys in the Borough.

2nd. To erect boundary monuments at the intersection of each and every street.

3rd. For a complete sewer plan of the entire Borough giving dimensions of sewers and showing location of streets, inlets and man-holes. Separate bids must be presented for each part of the work, but a bid for the entire work will be accepted in addition. Blue print of Borough plan will be furnished on application to Borough Engineer.

All bids must be in by April 1st, 1896. The Council reserves the right to reject any or all bids, and also reserves the right to divide the work, letting it out in parts to different contractors if they see fit. For further information apply to Borough Engineer. Mail to Clerk of Council, Oakmont, Pa.

February 17, 1896.

Electric Pumps.

"Electrically Operated Power Pumps" is the title of a handsome 44-page illustrated pamphlet recently issued by the Knowles Steam Pump Works, of New York, Boston, Chicago and London. The compiler of this pamphlet says in his preface that the pamphlet "is compiled, not from designs and data of types as yet largely on the drafting board, but from knowledge of apparatus already built and thoroughly proven in actual service." Pumps for almost all classes of service run by electric power are clearly illustrated and described. This pamphlet is sent free on request to every mine official.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any corrections in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Broken Shaft.

Editor Colliery Engineer and Metal Miner:

SIR:—I will be obliged if one of your readers will answer the following questions for me:

At Kangley Mine No. 2 we are using an endless rope system of haulage with 2¼ miles of ⅝" crucible steel wire rope worked with an engine of the Litchfield pattern with 12" × 20" cylinders and a 7 foot cog-wheel to which is attached a 4 foot drum. Placed 3 feet behind this drum is another drum which is equipped with Walker's slide rings. This drum is not connected with the engine, but is worked by the rope passing from the forward drum back over the Walker drum with five laps, thence to the tension wheel, and on to the inside. The shaft, which is a six-inch one, has broken at two different times within four months. What would cause the breakage of such a large shaft, it being only 4 feet long? Could the variations in the grooves of the drum made made by the wear of the rope cause the fracture?

If the drums were not set true with each other would that cause the break? Yours, etc.,

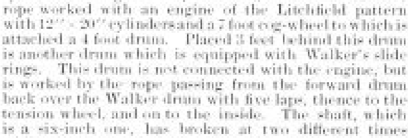
REESE NOLL, Kangley, Ill.

February 4th, 1896.

A Fan Question.

Editor Colliery Engineer and Metal Miner:

SIR:—Can you, through your paper, say whether a fan will give more or less air at a certain speed with one or two discharges of same area, and why?



A, B, C, all have same area.

Yours, etc.,

BAIRD SNYDER, JR., Asst. Supt.

Lansford, Pa., Jan. 29, 1896.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Will you please publish the following in answer to P. C., Dominion No. 1, C. B., Nova Scotia:

1\. Two shafts 6 feet by 6 feet, each 1,000 feet deep, pass 45,000 cubic feet of air per minute. How much must they be enlarged to reduce the power required one-half?

2\. In a certain mine there are 10,500 cubic feet of air per minute passing in an airway 5 feet by 6 feet and 2 miles long. Work was continued until the airway was 2½ miles in length, when a creep came on, which reduced the airway in area for 1 mile to 15 feet, or 5 by 3 feet, and for a further distance of one-half mile to an area of 10 feet, or 4 feet by 2½ feet. What quantity of air should then pass, the power remaining the same?

ANS. 1. The work done to pass a given quantity of air through an airway is expressed by the following equation:

$$\frac{k\,l\,o\,q^3}{a^3} = u. \quad (1).$$

Now, let x = length of one side of shafts after being enlarged.

Then $4\,x$ = perimeter.

And x^2 = area.

Whence $\frac{k\,l\,4\,x\,q^3}{x^6} = u$ for enlarged shafts. (2).

The value of u in (1) is twice that of u in (2).

Hence, $\frac{k\,l\,o\,q^3}{2\,a^3} = \frac{k\,l\,4\,x\,q^3}{x^6}$ (3).

Dividing (3) by $k\,l\,q^3$ it becomes

$$\frac{o}{2\,a^3} = \frac{4\,x}{x^6} = \frac{4}{x^5} \quad (4).$$

Clearing (4) of fractions, substituting known values and simplifying, it becomes $x^5 = 15{,}552$.

Therefore, $x = \sqrt[5]{15552} = 6.892$, and $x^2 = 47.4996+$.

ANS. 2. $k\,s\,v^3 = u$. Therefore, to pass 10500 cubic feet of air through an airway 5 ft. × 6 ft. and 2 miles long, it would require

$.00000001 \times [(2 \times 5) + (2 \times 6)] \times 2 \times 1760 \times 3 \times \left(\frac{10500}{5 \times 6}\right)^3 = 99697.2$ units of work.

The velocity through the altered airway will be inversely as the area, that is, if 1 be the velocity through 30 ft. area, 2 and 3 will be the velocities through 15 and 10 ft. area respectively.

The work necessary to pass the same quantity through the different sections will be proportional to $s\,v^3$.

Where the airway is

5' × 6' × 1 mile long	$s\,v^3$ = 22 × 1 × 1³	=	22.
5' × 3' × 1 "	$s\,v^3$ = 16 × 1 × 2³	=	128.
4' × 2½' × ½ "	$s\,v^3$ = 13 × ½ × 3³	=	202.5.
Total			352.5.

352.5 : 22 :: 99697.2 : 6216.62.

Therefore, 6216.62 units of work are spent in overcoming the friction of the air, through one mile of airway 5 × 6 in section.

$$\sqrt[3]{\frac{u}{k\,s}} \times a = q, \quad \sqrt[3]{\frac{6216.62}{.00000001 \times 1760 \times 3 \times 22}} \times 30 =$$

5247.48 cubic feet, the required quantity.

ADOLPHE COOK,

Feb. 20th, 1896. Houtzdale, Pa.

The Fifth or Higher Roots.

Editor Colliery Engineer and Metal Miner:

SIR:—The following rule for extracting the fifth or higher roots, without the aid of a table of logarithms, is of more universal application than any of those recently proposed in your "correspondence" column, and may be of interest to your readers. Let it be required to find the nth root of a, in which n and a are both positive numbers, whole or fractional.

Rule—Take b, some number, whole or fractional, whose nth root is known, substitute for a and b their values in the following equation:

$$k = 2\left[\frac{a-b}{a+b} + \frac{1}{3}\left(\frac{a-b}{a+b}\right)^3 + \frac{1}{5}\left(\frac{a-b}{a+b}\right)^5 + \&c.\right] (1).$$

Find the value of k from equation (1) and substitute for k and n their values in the following equation:

$$x = 1 + \frac{k}{n} + \frac{k^2}{1 \times 2 \times n^2} + \frac{k^3}{1 \times 2 \times 3 \times n^3} + \&c. \ (2).$$

Reduce and find the value of x. Multiply the value of x thus found by the nth root of b and the product is the nth root of a required.

(*Note*—The number b, should be assumed with the view of making the fraction $\frac{a-b}{a+b}$ as small as possible. Should the fraction $\frac{a-b}{a+b}$ be negative, change its sign and proceed as before, but place the second member of equation (2) equal to $\frac{1}{x}$ instead of x.)

Example—Find the fifth root of 9, (which is the problem given by Mr. Torey in your January number). Here $a = 9$, $n = 5$. Let $b = \left(\frac{3}{2}\right)^5 = \frac{243}{32}$.

Substituting these values of a and b in equation (1), we get $k = 2\left[\frac{5}{59} + \frac{1}{3}\left(\frac{5}{59}\right)^3 + \&c.\right] = .169807+$.

Substituting the values of k and n in equation (2) we get $x = 1 + \frac{.169807}{5} + \frac{(.169807)^2}{1 \times 2 \times 25} + \&c. = 1.034556+$.

Multiplying this value of x (1.034556+) by $\frac{3}{2}$ (the nth root of b), we find that $\sqrt[5]{9} = 1.551834+$, which is correct to 5 or 6 decimal places.

Yours, &c., S. A. COREY,

Feb. 3rd, 1896. Hiteman, Iowa.

The Fifth Root.

Editor Colliery Engineer and Metal Miner:

SIR:—I have read the explanation of the approximate rule for the extraction of the fifth and other roots by Mr. Thomas Hannah with interest and pleasure, but as practical mathematicians practise a more simple and more correct method when a table of logarithms is not to hand, I beg to give the rule for the assistance and encouragement of your most industrious correspondents. Suppose we require the fifth root of the number 14348907. By pointing off five places it becomes 143,48907, and by trial we see the root lies somewhere between the numbers 26 and 28, and we then proceed to reduce the number to the fourth power by dividing twice the given power by the sum of the trial roots, as

$$\frac{14348907 \times 2}{(26 + 28)} = 531441.$$

Then $\sqrt[4]{531441} = 27$, the true root. Or, to extract the biquadrate root, extract the square root of the square root. The sixth root can be found by the square root of the cube root, and the seventh root can be found by multiplying the given number by the sum of the trial roots, when the product will be double the eighth power of the root required, therefore divide by 2, and extract the square root of the square root, and the third root thus obtained is the required seventh root. The ninth root is found like the fifth by reducing, that is reduce to the eighth power.

Take care that in all cases that one of the roots is a little less, and the other a little greater than the required root. Yours truly, AJAX.

Otto-Hoffman Coke Ovens.

The plant of sixty Otto-Hoffman coke ovens erected at Johnstown, Pa., is now in operation. Mr. John Fulton furnishes us the following data regarding this plant:

The plant cost $301,500.23, including exhausting and condensing plant with ammonia factory, or $5,025 per oven. It is designed to add 60 ovens to this plant, at an estimated cost of $166,000. This addition shows the cost of each oven itself to be $2,766.66. The plant thus enlarged will exhibit a cost of $3,895.85 per oven, including by-product saving appliances. The exhausting and condensing plant, with ammonia factory, has cost $134,301.03, or $2,238.35 per oven for the 60 ovens now in blast, and for the 120 of proposed plant, $1,119.18 per oven.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue or three months subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for March.

QUES. 211.—As we are striving to make our proposed new safety lamp the best in the world, it certainly should be of some service in testing for gas, and as we require some additional information to enable us to make it so, let us band ourselves together for mutual help and we are sure to succeed. Then let us know at once what makes the gas cap tail up in a blue stream above the ordinary flame of the safety lamp.

QUES. 212.—When an explosion of fire-damp occurs in a coal mine, immense volumes of gas and air rush up and out of the shafts, and at the same time the expanded air and gas rushes into and becomes compressed in the gobs, do you think then that a correct sample of the after-damp produced by the explosion is procurable, and if so, where would you expect to find it? And while so doing, will you explain the recoil, or back rush of air into the levels, rooms, etc., after the blast has expended itself?

QUES. 213.—I am a mine superintendent for the Black Band Coal and Iron Co., and the principal director has requested me to read a paper before a meeting of the mine foremen of the district on the principles of construction and the mode of action of the electric motor, such as is used for mine haulage. He says the description must be brief and applied entirely to the magnetic field, and must only mention the commutator by a reference to its use. Now, as electrical appliances have come to the front for mining, I must either write this paper or lose my position, and I do think you will therefore make an effort to help me. Then, please give me the principal points required for a good paper.

QUES. 214.—We are about to open out a fine seam of bituminous coal that is 5 feet thick; and to work it we are going to sink shafts that will be 820 feet deep. Before, however, fixing on what should be the sizes of the shaft sections, we wish to determine what have to be the dimensions of the cars. The specific gravity of the coal is 1.27, and we want an output of 1,000 tons per day; will you, then, give us a sketch in elevation of the car you would recommend, and be careful to give the dimensions and capacity of the box, the sizes of the details of the bottom frame, and the sizes of the wheels and axles.

QUES. 215.—In surveying around the bottom of a mountain, we made all the necessary levels and insets to determine the correct figure of a truly horizontal base that was just touched by the western side of an outcropping coal seam. From the plat we found the figure to be practically that of an ellipse, with its major axis coursing from south to north 6,012 feet, and the minor axis coursing from east to west for 2,842 feet. The mountain is 1,800 feet high. The coal seam is 4 feet thick, and is overlaid with a strong sandstone. We levelled our transit at a distance of 64 feet eastward of the eastern end of the minor axis, and with the center of the telescope at an elevation of 4 feet 1 inch above the calculated level of the base, the bottom of the coal seam here made an angle of elevation of 38° 26', and the distance measured in a straight line from the plumb point on the ground to the bottom of the coal seam was found to be 1,026 feet. Now, I wish to know three things that I am sure you will calculate for me.

First.—What is the pitch of the seam?

Second.—What is the area of the seam?

Third.—What percentage of this seam could be reasonably worked? Show with a sketch how you find the pitch.

QUES. 216.—One of the air-ways in a mine is 6 feet high and 9 feet wide, and formerly a large volume of air was passed through it with a ventilating pressure of 1.2 inches of water gauge. Afterwards a regulator was fixed in this air-way to reduce the quantity passing to one-third of the former volume, and recently a new ventilating fan has been started at this mine, and it is treble the power of the former one. Now I will be obliged if you will determine for me five things:

First.—What is the length of the air-way, taking the co-efficient of resistance at .00000001?

Second.—What was the original quantity passing through the air-way?

Third.—What is the difference of pressure on the two sides of the regulator now, and what was it before the new fan was started?

Fourth.—What is the height of the water guage now for the drift?

Fifth.—What is the quantity now passing through the regulator in cubic feet per minute?

Answers to Questions which Appeared in the January Issue and for which Prizes Have Been Awarded.

QUES. 199.—In the construction of our new safety lamp, do you think we should adopt the principle of the tubular poles that are the distinguishing feature of the Gray lamp. This lamp is preferred for gas testing because it can detect a thin stratum of gas just under the roof of the seam. A shunt is provided in some "makes" of this lamp, to cut off the supply of air down the poles, and admit the supply above the glass cylinder, as in the Marsaut lamp, when it is not required to test for gas near the roof. Now I should like you to answer me three questions to aid me in deciding the point at issue:

First.—Why is the supply of air from the poles cut off when the lamp is in ordinary use?

Second.—When the lamp is fed with air from the poles, if you give it a quick sudden drop the light goes out. How is this?

Third.—When the lamp is carried in air charged with gas, if you move it quickly and suddenly upward, it fills with flame. How is this?

ANS. *First*—The supply of air from the top of the poles is cut off for ordinary use for three reasons: 1st. To prevent the entry of gas that might fill the lamp with flame; 2nd, if by any means the lamp was rapidly lifted it might fill with flame; 3rd, if the lamp was rapidly lowered when fed by the poles it might be extinguished.

Second—The air moves down the poles with a velocity due to the pressure set up by the motive column, and when the downward velocity of the lamp exceeds the downward velocity of the air in the poles the supply of air to the flame is cut off and the light is extinguished.

Third—When the lamp is suddenly lifted upward the supply of gas and air to the flame is increased and the result is the lamp fills with flame.

JOHN VERNER,
Lucas, Iowa.

Second prize, JOHN JENKINS,
Dingess, West Va.

QUES. 200.—We are going to prospect for coal, and at first we will only search for indications by examining the exposed rocks, and therefore we must get up in good shape our paleontology, in so far as the fossils that characterize the Silurian, the Devonian, the Carboniferous and the Triassic formations are concerned. Will you then assist us by naming the examples that we ought to know, and give them under four heads:

First.—Negative examples, as of the fauna of the Silurian and Devonian series.

Second.—Positive examples, as of the fauna of the Carboniferous and Triassic formations.

Third.—Negative examples, as of the flora of the Silurian and Devonian formation.

Fourth.—Positive examples, as of the flora of the Triassic and Carboniferous formations.

ANS. *First.*—Negative examples supplied from the Devonian fauna, are trilobites such as the Dalmania and phacops, and the characteristic ganoid fishes such as the cephalaspis, and among shells the spirifer formacula, a Devonian brachiopod. The Silurian fauna that give above all other examples, the most abundant negative indications of coal, are the graptolites, or peculiar sea pens of the period.

Second.—The footprints of reptiles on the bedding planes of the sandstones are first met with in the rocks of the Carboniferous period; and on the bedding planes of the shales of the same period lamellibranchs, such as the Solenomya anodontoides are frequently found. In the Triassic rocks the true encrinites, and beautiful cephalopods are found, such as the Ceratites nodusus, and now we find reptilian life most abundant and especially the teeth of labyrinthodonts.

Third.—Very few examples of plants are met with in the Silurian rocks, and what are found are lowly examples of acrogens, but the Devonian flora is somewhat abundant and is closely allied to that of Carboniferous times, although its negative character may be seen in its lower development.

Fourth.—Positive examples of the Carboniferous flora are abundant, such as pecopteris neuropterus, sigillaria, stigmaria, calamites, etc. Positive examples in the Trias, the peculiar horse-tails and coniferous trees.

JOSEPH VIRGIN,
Second, JOHN FLETCHER, Holsopple, Pa.
428 Tonti St., La Salle, Ill

QUES. 201.—In M. Murgue's theory of the equivalent orifice, the following equation is given: $A = \frac{.4Q}{\sqrt{WG}}$, and I will be obliged if you will inform me how he gets .4 for a constant. I know he takes the *vena contracta* at .62 and that A is the square feet in the equivalent orifice, Q is the quantity of air in thousands of cubic feet per minute, and $W\,G$ is the water gauge.

ANS.—The "equivalent orifice" depends upon the law that the speed of flow is the velocity due to the height of column of the flowing air, which is represented by the gravity formula,

$$V = \sqrt{2\,g\,h}.$$

The quantity passing through an orifice in a thin plate is taken as 0.62 of the quantity due to the area of the whole orifice. Hence, for the *vena contracta* the formula becomes

$$V = 0.62\,A\sqrt{2\,g\,h}, \text{ or,}$$

$$A = \frac{V}{0.62\sqrt{2\,g\,h\,\frac{d}{d'}}}$$

In the last, equation, as h must be reduced to air column, there is introduced the factor $\frac{d}{d'}$ expressing the relative densities of water and air.

Simplifying this equation for water gauge as usually taken in inches, remembering $2\,g = 64$, we have

$$A = \frac{V}{1.43\sqrt{h\,\frac{d}{d'}}}$$

The normal relative densities of water and air being 1,000 and 1.2; this becomes $A = \frac{V}{41.28\sqrt{h}} = \frac{0.024\,V}{\sqrt{h}}$.

In the above, V = volume in cubic feet per second. The volume in thousands of cubic feet per minute is used by Murgue. Representing this by Q, the equation becomes

$$A = \frac{24\,Q}{60\sqrt{h}} = \frac{0.4\,Q}{\sqrt{h}} \text{ or } \frac{0.4\,Q}{\sqrt{W\,G}}.$$

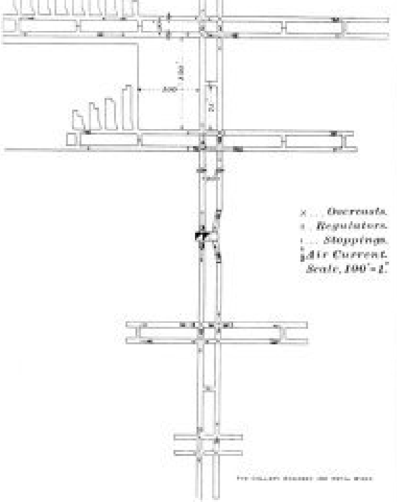
J. J. ORMSBEE, Henry Ellen, Ala.

Second Prize, JOSEPH JAMES,
Sioux Falls, South Dakota.

QUES. 202.—We have a seam of coal with a soft wet floor, and the immediate roof is a slate 2 feet thick and it falls. The seam is 4 feet thick, is at a depth of 612 feet, and consists of a soft coking coal lying nearly level.

We have tried longwall working and it has proved a great failure, as the packs sink into the floor. We have 700 acres available and the field is nearly square. The coal is valuable for coke making and we cannot give it up, then will you send us a neat plot of how you would work it. You might locate your shafts in the middle of the field; and give us the sizes of your roads, and pillars, if any.

ANS. I would work this seam on the room and pillar double-entry system and would if possible drive each entry to its limit before starting any rooms on it and would begin to draw the room pillars and entry stumps



together as soon as the rooms were up, starting rooms at the end of the entry first; in this way we would maintain good haulways, drainage and ventilation, with the least waste of coal from crushing and the least danger of gob fires, etc. The dimensions, the sizes of the roads, pillars, etc., and courses of the air are given in the sketch.

CHAS. ED. BOWRON,
Tracy City, Tenn.

Second prize, H. K. MOBERLY,
West Newton, Pa.

QUES. 203.—The same coal seam is pitching heavy in one region and in another it is lying quite level. The thickness and quality of the coals are, however, equal in the two cases, and we wish to invest in one of them, which do you prefer and why?

ANS. The areas and the qualities of the coals not being given. I will assume that the areas are equal, and that the qualities are first-class bituminous, and under such conditions I would, if the level coal is dry, prefer it to that lying in the pitching region for the following reasons:

First—There is less probability of the coal cropping out in the level field than there is in the pitching one.

Second—The level region furnishes a choice of location for the shafts, and better facilities for drainage, hoisting and ventilation.

Third—The level coal can be worked by any system that will favor a reduced cost and less crushed and injured coal.

Fourth—No pillar coal need be lost, or at any rate a higher percentage of the level seam can be secured than that of the pitching one.

Fifth—The first cost and maintenance of cars, ropes and roads is much less for a level seam than for a pitching one.

JAMES TASKER, Old Forge, Pa.

Second Prize, P. H. CARROLL, Vivian, W. Va.

QUES. 204. We have three mines all working the same vein, and we will call them A, B and C. The cover, the floor and the depth and thickness of the coal are in all the cases about equal and the system of working this 4 foot vein is the same at each mine, and that is longwall advancing. Now the superintendent at A, works on the principle of having plenty of "pit room" or a working face far in excess of that required for immediate use. The superintendent at B keeps no more working face open than is required for immediate use, but believes in having all ready for unexpected events. The superintendent at C does not believe in plans for future working, because, says he, some one may come after him and reap the harvest of his labor. This being a good presentation of the three cases, will you please give them your close attention, and let me know at your earliest, how it is that only one of these mines pays the company, while the other two are a "dead" loss, and be careful to say which mine pays, and show the reasons why it does so.

ANS. I vote for the superintendent at A. For pillar and room workings, no doubt B's policy would be good, but for *longwall* you cannot help having "plenty of pit room" if you are working the right way. In longwall, you have water and falls to provide for, and if you had not more face than that immediately required, you would not employ more than two-thirds of your men. A can, therefore, always be depended on for a full day's work and an increased output at a moment's notice. After longwall is opened up and settled, it is easily and cheaply kept open.

I am therefore sure that B and C could not by any means make their longwall pay, for longwall cannot be worked to profit when the face is crowded for coal.

WILLIAM HODGE,
Forbush, Appanoose Co, Iowa.

Second, JOHN FLETCHER,
428 Tonti St., La Salle, Ill.

[A very great number of competitors sent in answers to question 204, and they all except, the two gentlemen just mentioned, went in for B. Now had the workings been room and pillar, no doubt B was the man; but as they were longwall, B and C must have been working with fast sides in longwall panels, and therefore chopping and pounding the coal into slack, with the result that the mines could not pay. Again, you cannot have a circular or semicircular longwall face, and restrict the length of the face to the requirements of your men, for if you do, you must work with fast sides, and stand by the consequences. We hope our friends will be more careful to read the conditions of the questions in future. —ED.]

Examining Boards for Mine Inspectors

Owing to the illness and continued absence of Hon. Mason Weidman, Judge Bechtel, of Schuylkill county, postponed action on the appointments for the several examining boards until late in January, hoping that Judge Weidman would reach home in time to participate in the selection of the appointees. These appointments should have been announced on the first Monday in January. On Jan. 31st Judge Bechtel announced the following appointments:

Board to examine applicants for the offices of mine inspectors for the Sixth, Seventh and Eighth districts:

Engineers.—Heber S. Thompson, Pottsville; John R. Hoffman, Pottsville.

Miners.—James Roberts, Girardville; Frank Kessler, Forestville; James J. Brennan, St. Nicholas.

The only change on this board was the substitution of Mr. Brennan, who succeeds Mr. John W. Dempsey, of Minersville, whose recent promotion renders him ineligible.

To examine applicants for mine foremen's certificates:

Sixth District.—William Stein, mine inspector, *ex officio*, Shenandoah; William H. Lewis, superintendent, Shaft P. O.; Frank Wilcoxen, miner, Shenandoah; M. J. Brennan, miner, East Mahanoy township.

Seventh District.—Edward Brennan, mine inspector, *ex officio*, Shamokin; Andrew Robertson, operator, Shamokin; Robert Muir, miner, Mt. Carmel; Adam Bachman, miner, Ashland.

Eighth District.—John Maguire, mine inspector, *ex officio*, Pottsville; Thomas Doyle, superintendent, Pottsville; Thomas Holahan, miner, Middleport; David Tucker, miner, Pottsville.

The Lehigh Valley Coal Co. Absorbs the Interests of L. A. Riley & Co.

For some months past negotiations have been pending which culminated Feb. 15th in the absorption of the interests of the firm of L. A. Riley & Co. by the Lehigh Valley Coal Co.

The firm of L. A. Riley & Co. have, for a number of years, been the operators of the Centralia and Logan collieries, at Centralia, Pa., and more recently of the Big Mine Run colliery, near Ashland, Pa. The firm also controlled the lease of what is known as the Germantown tract. All of these interests will on March 1st pass into the hands of the Lehigh Valley Coal Co. The collieries included in the transfer are large ones, producing in 1894 294,790 tons. They afforded employment to nearly 1,200 people. The acquisition of the Germantown tract by the Lehigh Valley Coal Co. in all probability means the early development of it. Surveys have already been made and a preliminary route laid out for a railroad to this tract. The location adopted is said to run from a point near the old Continental colliery northwest to the point of Locust mountain, thence along the mountain side touching Byrnesville, thence into the tract. The immense store at Centralia was not included in the deal, but the business will be carried on by a separate company with Mr. Theodore F. Riley as general manager.

The money consideration involved in the transaction has not been made public.

(Continued from page 177.)

wearing down of the Upper Silurian and Devonian rocks. The geological survey in 1852 determined the existence of gold-bearing alluvions over an area of 10,000 square miles in Quebec and Nova Scotia, also along the Chaudiere river.

In British Columbia gold was discovered on Frazer river in 1858, causing a great "rush" of prospectors. San Francisco was nearly depopulated. Gold was traced 300 miles up the river to Cariboo. On Peace river, 250 miles still further north, gold was also found. In 1872 discoveries in the Cassiar district, 800 miles north of Victoria, caused the "Stickeen river rush." The Frazer river deposits paid only to a limited extent and were soon worked out. The workings were principally in shallow placers and river bars, but at Cariboo there are channels beneath the bed of the present watercourses. Shafts are sunk from the surface to the gold-bearing channels through a covering of clay and gravel. The bed of the ancient stream when reached is followed and worked by drifts. The expense of working owing to a superabundance of water to contend with has caused operations almost to cease. North of this the climate is an obstacle, as work can be carried on only during a few months of the year. Gold is found in the Leech river, in Vancouver Isle. From 1858 to 1880 $45,140,889 has been extracted from the placers of British Columbia.

To the other gold placer deposits in North America we shall devote a special article, after this general sketch of the distribution of gold deposits over the world, for the materials of which we are largely indebted to Bowie's admirable treatise on hydraulic mining.

MODERN STEAM PLANT FOR MINES.

An Economical High Pressure Water Tube Boiler Plant Erected by the Lehigh Valley Coal Co.

In mining, as well as in every other industry, the profits depend entirely on the degree of economy secured in production. In anthracite coal mining, and, to a great extent, in bituminous coal mining, the conditions are such that in many cases the profits on mining and preparing coal are *nil* or "*minus*" unless advantage is taken of every opportunity to reduce cost of production. No persons realize this more than the practical men at the heads of the larger companies engaged in the business. This necessity for greater economy, together with the necessity for more effective steam power at engines and pumps located at a distance from the boiler plants, has resulted in a marked improvement at colliery steam plants. The old wasteful cylinder boilers which carried but 70 or 80 pounds of steam, and which only furnished a distant pump or engine steam at 40 or 50 pounds pressure, are rapidly being superseded by improved high pressure boilers, which generate steam more economically and which are capable of supplying steam to distant points at a more efficient pressure.

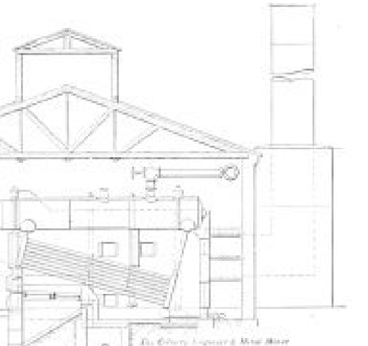


Fig. 1. Side Elevation.

One of the latest of these improved plants is the one illustrated herewith.

The Figures 1 and 2 show the general outlay of 1,500 horse-power Babcock & Wilcox water tube boilers as installed for the Lehigh Valley Coal Co. at their Hazleton No. 1 colliery, Hazleton, Pa. The plant consists of six boilers of 250 horse-power each, arranged two in a battery, so connected that each 250 horse-power can be run independent of the other. Each 250 horse-power is connected to two steam and water drums 42 inches in diameter and 23 feet 3 inches long, providing a steam disengaging surface and steam storage capacity perfectly in accord with the heavy demands of colliery work. The boilers are designed for a working pressure of 175 pounds to the square inch.

The boilers are of special design, built for burning very low grades of anthracite fuels. They have a grate area of 68 square feet for each 250 horse-power, each grate being 9 feet 8 inches wide by 7 feet deep, having three fire doors, with an uninterrupted fire surface the full width of the boiler without any intervening brick arches to necessitate constant renewals. The furnace is made low to secure the best results from the short flame incident to the combustion of the fuels now being generally used throughout the anthracite district, which fuels contain as high as 52 per cent. ash. The fuels used at this plant consist of the chippings and dirt from the breaker rolls, conveyed from the breaker direct into the boiler room, thus saving all handling of fuels.

There is provided throughout the entire front of the plant an ash-tramway (see A, Fig. 1). The ashes from the grates dump directly into the car, and removable plates in the floor provide a dump for ashes when boilers are being cleaned. The connecting duct from the inclined chute from the grates to the ash car is closed with a damper, connected to the front of the boiler.

An underground air duct running the entire length of the plant is shown at *B*, Fig. 1. This duct is connected through the bridge wall with hollow blast boxes controlled by a lever from the front of each boiler, by means of which the introduction of air can be regulated to suit the conditions of running the plant.

On plan view, Fig. 2, is shown a duplicate fan system (see *A* and *E*) for the introduction of forced blast under the grates. In combination with the blast the exhaust steam from the breaker is conducted into the underground duct (*B*, Fig. 1), and takes the place of the old system of utilizing live steam under the grates to prevent clinkering. The latter practice entails a usage of not less than 8 per cent. of the steam generated.

The plans as shown have been modified by the adoption of a single blast fan of larger capacity, to work separately or in combination with an induced draught system. The stack used in connection with the induced draught is but 40 feet high from the boiler room floor, and is provided with dampers by which the fan can be closed off entirely from the system and the stack used for a natural draught in connection with forced air blasts under the grates. Both the forced blasts and the induced draught system are of sufficient capacity to be run independent of the other. The feed water is passed through an American Fuel Economizer installed in the flue leading to the stack, thus utilizing all the heat in the waste gases and passing them at a very low temperature out of the stack. The economizers are fitted with an automatic cleaning device, which prohibits any collection of fine dust on the surface of the tubes. The working of the whole plant, both as to induced draught and forced draught, is automatic, and the speeds of the fans are regulated to suit the demands on the boilers.

The operation of the 1,500 horsepower is conducted by eight men, four to a shift of twelve hours each, making an actual saving in labor over past practice at this plant of over seven thousand dollars per year.

The plant as installed was under the immediate supervision of the designer, Mr. Samuel D. Warriner, Mechanical Engineer, Lehigh Valley Coal Co.

Mine Equipment.

That steam pumps form a very important part in mine equipment and operation is well attested by the number of advertisements of same by prominent pump builders regularly appearing in The Colliery Engineer and Metal Miner. These advertisements are worthy of careful note by mine superintendents and operators, for, as now arranged, they show almost at a glance the salient characteristics of design of nearly all the leading builders in such a way as to afford easy comparison of patterns.

One steam pump advertisement, for the first time appearing in this issue, is that of the Fred M. Prescott Steam Pump Co., of Milwaukee, Wis. This advertisement during the course of its publication will be something more than an "illustrated business card" of the concern named. It will be noted that in this issue is shown a photographic reproduction of a pump constructed for mining service, and notes appended stating where and under what conditions it is in use. This advertisement is virtually a news item and a good one at that. In our next and succeeding issues the same practice will be followed. The Prescott Co. have thus far made a specialty of pumps for mining service, and their ability to cope with the severe conditions imposed in this work needs no other testimony than the "repeat" orders (some several times repeated) they have received from large mining concerns. By means of these advertisements mine superintendents and operators will be kept informed on "Prescott" pumps and it will be worth while to note each carefully as they appear, for each one will show a pump actually built, where it is in use, and conditions of service.

The Edward P. Allis Co., of Milwaukee, Wis., is another new advertiser in The Colliery Engineer and Metal Miner. In what may be termed heavy mine equipment, the list of what the Allis Co. does not build would be far shorter than a catalogue of what they do put out. In their advertisement they simply group it all under "Mining Machinery," including in this everything from power plant to special machinery for treatment of ores of all classes.

In no class of engineering are better measuring instruments required than in mine surveying. For this service steel tapes have, very properly, superseded the chain. The number of makers of steel tapes for engineers' use is comparatively small, however. The Lufkin Rule Co., of Saginaw, E. S. Mich., is the largest in this country making these goods exclusively, if not in the world. They make everything in measuring tapes from the little ones of a single yard in length to those of 2,000 feet and upwards for artesian well measurement, and of qualities guaranteed unsurpassed. Some of their specialties in tape reels and cases are marvels of convenience in use. This concern begin with this issue an advertisement of their goods, and hereafter will keep "Lufkin" rules and tapes prominently before the mining fraternity. It will be worth the while of every civil and mining engineer to send to the Lufkin Rule Co., for their catalogue and inform himself concerning these goods.

In the line of machinery for elevating and conveying coal, ore or other heavy material the Brown Hoisting and Conveying Machine Co., of Cleveland, Ohio, has for years enjoyed an enviable reputation. The appearance of their advertisement in this issue will make their specialties known to mine managers throughout the country who will find it to their interest to send for catalogues of their machinery, and to bear them in mind when erecting new plants or remodelling old ones.

Adequate steam pressure at points of utilization, economy in steam production and safety, are prime requisites of the boiler plant at every mine. A cheap boiler that is cheap only in first cost is expensive in every instance. Heine Safety Boilers, which are advertised in this issue, are fast gaining in favor for mine use. The manufacturers guarantee their superior merits.

The Foster Engineering Co., of Newark, N. J., are manufacturers of superior types of reducing valves, pump governors, and in fact a large number of most excellent steam specialties, some of which we hope to describe in detail in future issues of this journal. Their specialties are of such a nature that every mine manager should know all about them. One of their catalogues should be in every mine manager's hands.

Lumber is a mine supply that is in constant demand. Among the number of other advertisers making a specialty of mine trade in lumber, is the Commonwealth Lumber Co., of Scranton, Pa. Their advertisement appears for the first time in this issue.

An Efficient Type of Boiler.

H. E. Collins & Co., Pittsburg, Pa., sole sales agents for the Cahall Vertical Water Tube Boiler, manufactured by the Aultman & Taylor Machinery Co., Mansfield, Ohio, report the following recent sales of Cahall boilers: National Chemical Co., Cleveland, O., 150 H. P. Republic Iron Works, Pittsburg, (fourth order) 250 H. P. Municipal Electric Lighting Plant, London, Ohio, 250 H. P. Voight Brewing Co., Detroit, Mich., 500 H. P. Michigan Alkali Co., Wyandotte, Mich., (fourth order) 300 H. P. Jefferson Coal Co., Coal Glen, Pa., 500 H. P. Ohio Iron Co., Zanesville, Ohio, 500 H. P.

The boilers for the Republic Iron Works are for the utilization of waste heats from heating furnaces; those for the Ohio Iron Co., are for blast furnace gas and the balance of the orders mentioned are for boilers of the direct coal fired type.

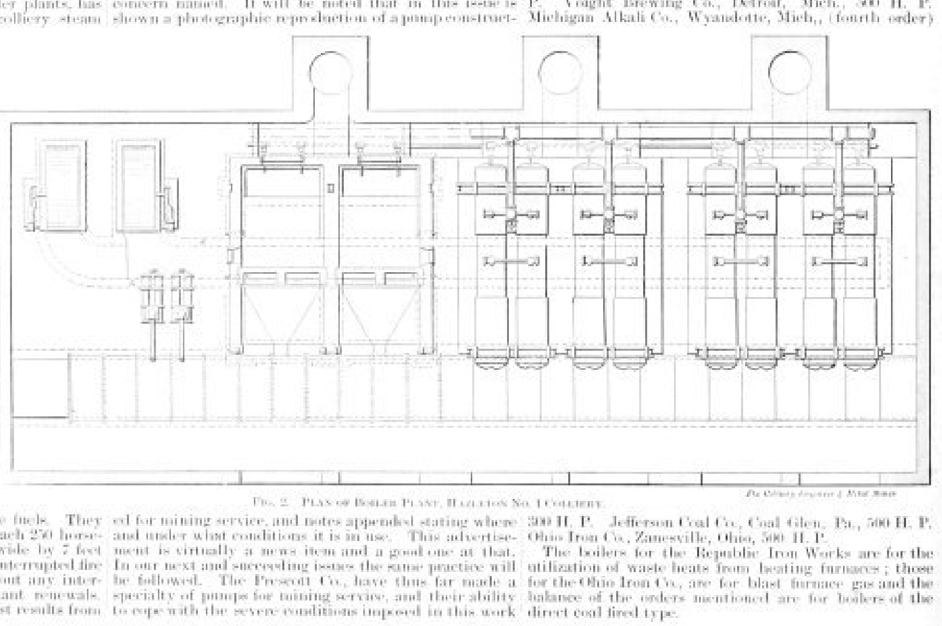


Fig. 2. Plan of Boiler Plant, Hazleton No. 1 Colliery.

THE PROGRESS IN MINING.

Abstracts From the Proceedings of the Mining Societies

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

WATER CARTRIDGES FOR BLASTING.—The following article by L. Jaroljmek was translated from the German for the *Colliery Guardian* :

To Minimize the Danger of Blasting.—It has all along been the predominant idea in the minds of all connected with the technology of explosives, to minimize the danger of blasting operations. They can, however, only be considered safe provided the cartridges fulfil the following requirements:—(*a*) Abolition of manipulation in igniting; (*b*) rejection of the present detonating materials; (*c*) absence of the necessity of tamping as now understood; (*d*) substitution of a perfect tamping material; (*e*) effective cooling of the gaseous products of explosion. A new process to comply with these conditions must be automatic, requiring neither fire nor spark to produce ignition—*i. e.*, must effect this object by chemical action in the interior of the cartridge. It will further need to abolish existing methods of tamping and employ instead a naturally more resistant material. This may be accomplished, as experiments with plaster, &c., have shown, by the use of liquid or semi-fluid substances, and if the fluid be employed, not only as a tamping but also as the igniting agent—so that it becomes absolutely necessary for firing the shot—it cannot be neglected by the workmen, and will therefore become available for satisfying the condition (*c*).

The Jaroljmek water cartridge is said to fulfil all the foregoing requirements, being automatic, and requiring no spark or light for ignition. Briefly described, it consists of a cartridge of dynamite, into which is imbedded one end of a cap containing in its lower extremity a charge capable of ignition at between 100° and 120° Cent., the part fitting into the dynamite being loaded with an exploding charge of fulminate sufficient to produce the requisite initial impulse. The base is formed by a cartridge of pressed quicklime covering the lower end of the cap, and when the cartridge is surrounded by water the lime absorbs a portion of the liquid, becoming thereby hydrated and evolving sufficient heat to fire the inflammable cap, which thereupon ignites the fulminate and initiates the explosion. The whole cartridge is surrounded by a cover of cotton cloth.

In order to regulate the absorption of water by the lime, the lime cartridge is covered by a capsule of metal foil, the rate of absorption depending on the surface left exposed by the capsule. The lime cartridge is, for the purpose of insuring the unimpaired maintenance of its quality during storage and transport, provided also with a tight-fitting lid, to be removed before the cartridge is attached to the dynamite charge, and the cartridges are timed to produce explosion at any desired interval after insertion in the borehole, from 1 to 2½ minutes and over. The last-named figure represents the minimum interval for cartridges in coal mines, the former sufficing only for quarries and similar cases.

Advice of Committee on Fire-Damp.—The Ostrau-Karwin special committee on fire-damp advises the following procedure for fixing and firing the cartridge: In holes sloping downward the explosive charge is inserted first and the water poured in after adjusting the igniting cartridge. Where the holes are horizontal, or with but a gentle slope, it will be necessary to make a small dam of clay in order to cover the cartridge properly with water. For holes leading in an upward direction, a small spring is affixed to the bottom of the cartridge to prevent slipping back, and in such cases a water-cartridge must be used. This is made of a paper cylinder about 40 cm. long, closed at the lower end (paper soaked in paraffin will be sufficient for this purpose) and large enough to hold an amount of water equal to three or four times the weight of the blasting charge. It should have a diameter slightly less than that of the borehole, so that it may be easily inserted in the latter. When placed in position the conical base of the lime cartridge comes in contact with the water, this contact being insured, and the spilling of the water prevented by a wad of cotton inserted in the mouth of the water-cartridge. This latter can also be employed in downward holes, if there is likelihood of the water escaping through fissures, or may be replaced by a tamping of moss soaked in water.

The apparatus was subjected to a series of tests in May and July, 1895, with the special object of ascertaining how far the timing of the lime cartridge (or cone) could be relied on as accurate. In these tests, both uncovered and "timed" cones of different sizes were used, and the porous material for enveloping the cartridge was subjected to comparative examination. Shots were fired with different caps and varieties of dynamite—true and imitation—as well as blank cartridges (caps only). From the tables of results furnished it is deduced that where the lime cones are partly enclosed by a cover, the time elapsing between the application of the water and the firing of the shot is in inverse ratio to the amount of absorbent surface exposed, and that, furthermore, the texture of the cotton tissue in which the whole cartridge is enveloped exerts a similar effect, viz., the closer and denser the cloth the longer the interval before the explosion ensues.

The practical results to be drawn from the table are: (*a*) That shots timed to at least one minute can be obtained by the use of the small lime cones covered over with cylindrical cotton wick, but surrounded by a band of metal foil only so far as their cylindrical portion is concerned, the cone being unprotected. (*b*) Reliable shots timed to 2½ minutes, and not varying by more than 1 minute, can be produced by means of lime cones enveloped in foil except on the face, and encased in a cylinder of cotton tissue. In neither case were there any delayed shots observed in these tests.

The examination was extended to the effect of unfavorable surroundings on the efficiency of the cartridge. For instance, such as firing shots:—(*a*) In very wide wet boreholes or water-bearing rock; in free-lying blasting charges under water; to dislodge misfires by inserting a new cartridge in the water tamping. (*b*) In upward-sloping holes. (*c*) In holes pointing vertically upwards (roof shots). Here also favorable results were obtained leading to the following conclusions:—First, that when a blasting charge fitted with a "timed" lime cone is inserted into the water tamping of a wide borehole, or even merely dropped into water, the shot will be fired at the interval to which it is timed. This allows boreholes sloping in a downward direction to be filled the simplest and safest way, a point of particular importance in quarrying and surface blasting. In submarine work the cartridge, enclosed in a lead pipe, merely requires lowering till it rests on the spot to be blasted. Secondly, that the angle at which an upward hole is inclined has no effect on the timing of the cartridge. The difficulty of supplying the water decreases as the angle of inclination falls below 45 degs., and with the timing of the shot, but the removal of misfires in upward holes requires more care on the part of the miner when water cartridges are used than in the case of moss tamping.

The Flame of the Shot Completely Stifled.—As regards the behavior of the cartridge in fiery pits or air containing coaldust, it is claimed that communication between the igniting flame and the air is altogether excluded by the mass of lime surrounding the detonator. The lime being impregnated with water vapor, contact with methane or coaldust is prevented. Furthermore, the presence of water in the borehole is, as is well known, sufficient to prevent flame accompanying a blown-out shot; and, in the case of the present cartridge, additional security is afforded by the lime, which expands owing to the combination it enters into with the water, sufficiently to fill the borehole before the charge is exploded, and this, too, even if only the smaller lime cones are used, a still greater amount of security being afforded by the larger sizes. In fact, the lime cone, even when but little water is at hand, is by far the most effective tamping for preventing blown-out shots, a matter of particular importance for upward holes, which are mostly tamped with wet moss only.

The blasting charge is surrounded, so far as concerns the igniting cartridge, by means of the water absorbed into the lime and into the porous envelope. As for the remaining portions of the cartridge, it is manifestly only feasible to surround these with water in the case of downward holes, except in so far as the water is taken up by the porous envelope. The filling the annular space surrounding the cartridge with water is a special feature of the method, as it is considered that if the cartridge were pressed tightly into the borehole in the manner usually practised, a good deal of the security against ignition of gas afforded by this system would, under unfavorable circumstances, disappear. Of course, in upward holes it is impossible to envelop the cartridge with water; but it must not be forgotten that holes of this character are comparatively rare, particularly in fiery mines, where they should be carefully avoided. The occurrence of blown-out shots in these holes is very rare, but in extremely risky cases safety dynamite or similar explosive could be used in place of the ordinary charge.

Test Explosions with Blown-out Shots.—Test explosions with blown-out shots were made in a gallery of the Wilhelm shaft at Poln.-Ostrau, with a 6.8 per cent. mixture of fire damp and finely-powdered coaldust kept in constant circulation in the chamber, the cartridges being inserted in a hole bored in a large steel ingot until this burst, whereupon a block of cement was used and arranged to give a blown-out shot. Various modifications of tamping were made, sand and coaldust being used as well as water. In no case, however, was the gas in the chamber ignited. Similar results were obtained by the Rossitz-Oslavan special committee, explosive mixtures of fire-damp not becoming ignited, although ordinary dynamite was exclusively used and minimal quantities of water put into the holes. Both these committees reported favorably on the cartridge, the first named stating that the Jaroljmek cartridge is a central-fire apparatus, and offers greater security against the ignition of firedamp than the electrical fuses in use, the expansion of the lime cartridge being very effective in increasing the action of the explosive and preventing blown-out shots. Only water or moss tamping is required, and the operation is cheaper and no more complicated than electric fuses. For fiery mines it is particularly to be recommended. The Rossitz committee state that it is evident from the result of the tests that it is possible to adjust the lime cone to prevent the ignition of the detonating cap before a definite time. The fact that water is necessary in order to make the cartridge explode forces the workman to use water tamping, thus obviating the danger occurring from the employment of explosives in boreholes in fiery pits. Furthermore, the lime in the Jaroljmek cartridge forms a second tamping in the borehole and offers additional security against the escape of flame, so that the committee consider the method an absolutely safe one for use in gassy mines.

* * *

EXPERIMENTS WITH EXPLOSIVES.—From the Transactions of the Federated Institution of Mining Engineers, England. Some important experiments with explosives were recently made at the experimental station of the Ince Hall collieries near Wigan, Lancashire, England. This station has been fitted with all the requisite appliances for testing explosives by the owners, Messrs. Pearson and Knowles. The apparatus consists of a boiler 30 feet long and 5 feet 10 inches in diameter. One end of the boiler is open, and provision has been made for forming when necessary a gas chamber at the closed end, and this is done by fixing in an air-tight partition eight feet from the end. Along the sides of the boiler are three windows for making observations. On the bottom of the boiler at the closed end a mortar is fixed in masonry for firing the charges, and the shots are fired by electricity. Such in short is the fit up that is called the experimental station. The experimentists now under notice were Messrs. E. W. Thirkell, A. A. Atkinson and M. Hall.

One set of experiments were tried as strength tests and these were done by setting the mortar outside in the open, and firing it in every case at an angle of 55° elevation, and using a 35 pounds projectile with a charge, in each case, of 10 grammes, or .35 of an ounce of the explosive tested, and the exploding was done with No. 6½ detonators, and disregarding the order in the succession in which the shots were fired the following were the distances in feet to which the projectiles were thrown by the charges of the different explosives:

Name of Explosive.	Weight of Projectile.	Weight of Charge.	Distance the Projectile was Thrown.
	Pounds.	Grammes.	Feet.
Bellite	35	10	316
Dynamite	35	10	408
Roburite	35	10	192
Westphalite	35	10	402
Ammonite	35	10	324½
Tonite	35	10	219
Carbonite	35	10	241½
Blasting powder	35	10	165
Ardeer powder	35	10	84

The following table gives the results of the inflammability of the different explosives tested. Half a cubic foot of fine coal dust was thrown near the mortar just before the charge was fired in each case:

Name of Explosive.	Weight of Charge.	Exploded. Yes or No.	Flame. Yes or No.
	Ozs.		
Ammonite	12	Yes, Violently	Yes, Large
Carbonite	12	No	No
Roburite	12	Yes, Violently	Yes, Large
Bellite	12	Yes, Violently	Yes, Large
Westphalite	12	No	No
Tonite	12	Yes, Violently	Yes, Large
Ardeer powder	12	No	No
Compressed powder	8	Yes, Violently	Yes, Large
Dynamite	2	No	No

All the shots were fired without stemming to imitate the results of a blown-out shot.

* * *

FATAL ACCIDENTS IN THE MINES AND QUARRIES OF GREAT BRITAIN IN 1895.—We have to hand from the Under Secretary of State, the tables of "Fatal Accidents in and About the Mines, of Great Britain and Ireland," (including those on private branch railways and tramways, and in washing and coking coal) during the year 1895."

The total number of fatal accidents in and about the coal mines, for the year, was 1,033, and the following is the order of the classification of the causes:

EXPLOSIONS.	
Explosions of firedamp or coal dust	55
FALLS IN MINE.	
Falls of sides	88
Falls of roof	330
IN SHAFTS.	
Overwinding	2
Ropes and chains breaking	1
Whilst ascending or descending by machinery	36
Falling to shaft bottom from surface	6
Things falling from surface	2
Falling from part way down	17
Things falling from part way down	12
Miscellaneous	21
MISCELLANEOUS UNDERGROUND.	
By explosions	21
Suffocation by natural gases	5
Irruptions of water	94
On inclined and engine planes	59
By trams and tubs	84
By machinery	2
By underground fires	12
Ropes and chains breaking	18
Sundries	29
ON SURFACE.	
By machinery	17
Boilers bursting	3
Railways and tramways	62
Miscellaneous	37
	1,033

The classification of the causes is well done, and cannot but be appreciated by practical men.

* * *

DAMPING COAL DUST IN MINES.—The following is copied from the Continental Notes of the *Colliery Guardian.* Arrangements for damping coal dust in the Hibernia Colliery, Westphalia, are now extended to all the seams; and for collecting the water supply there is a lodge at the level of 340 m. (186 fathoms) with a capacity of 552 cubic metres, or three times the quantity necessary for a day's use. When the mine water becomes insufficient the reservoir is filled by two pumping engines, erected at the level of 610 m. (333 fathoms), that work alternately, the water in either case being filtered through a layer 2 m. (6 ft. 6 in.) thick of broken slag, held in place by planks bored with holes. The outlet branch pipes in the cross-cuts have a diameter of 52 mm. (2 in.); and the pipes leading from the latter to the working places, half that diameter, while the whole length of piping is about 45,820 m. (50,110 yards). The pipes, which are in lengths of 5 m. (16 ft.), are of wrought iron, galvanized to protect them from rust, and jointed with loose flanges and india rubber washers. In order to permit of thoroughly damping all the workings, every 50 m. (54 yards) three-flange unions are introduced, each of which is fitted with a hydrant carrying shut-off cock and union joint. In front of the working faces there are also hydrants with shut-off cocks and union joints, the total number of hydrants being 1,016. In addition to the shut-off cocks on the hydrants there are 140 others, by means of which the branch pipes may be shut off for repairs or lengthening the service pipes. The damping is effected by india rubber hose screwed onto the hydrants, and their nozzles consist of short pieces of gas pipe with a 3 mm. orifice. The sprinkling of the coal dust is effected, in front of the working places, by men appointed for the purpose, of whom there are at present thirteen; and the faces of stone drifts are also regularly provided with sprinkling apparatus. In some places, for ventilating separate workings, as well as preventing collections of fire-damp where cavities have formed in the roof, ten fixed roses and also Peltzer fans are provided. Up to the present time, states the *Zeitschrift für Berg und Hüttenwesen*, no injurious influence of any consequence has been noticed in the workings of this colliery; and the total expenses of the damping arrangements, including erection, extension and maintenance of the plant, and also the work in connection with it, has not quite amounted to 178,800 marks (£8,940) for the five-yearly period ending with last June.

* * *

IMPROVED MODES OF WORKING COAL.—From the "Continental Notes of the Colliery Guardian" we learn that the German miners are making great advances in the adoption of better modes of working to increase their output of coal, as the following extract shows:

Last year, 162 collieries in the Dortmund Superior Mine Inspection district put out 41,145,745 tons, with a mean of 154,638 hands, against 40,613,073 tons, with a mean of 152,698 hands in 1894, thus showing an increase of 532,672 tons. Of the ninety-five collieries which have joined the Rhenish-Westphalian Coal Syndicate, whose collective participatory output for the present year is limited to 41,631,243½ tons, it is the Centrum Colliery which will supply the odd half ton over 758,301 tons, and six collieries will contribute more than one million tons each—viz., the Ahrenbergische Aktien-Gesellschaft 1,233,916 tons; the Consolidation, 1,169,578 tons; Gelsenkirchener Bergwerks-Aktien-Gesellschaft with Monopol, 3,455,753 tons; Harpener Bergbau Aktien-Gesellschaft with Mont Cenis, 3,465,988 tons; Hibernia, 2,034,195 tons, and Zollverein, 1,395,507.

* * *

SAFETY EXPLOSIVES.—A Paper Read Before the North of England Institute of Mining and Mechanical Engineers. The secretary (Mr. M. Walton Brown) read a paper contributed by Bergassessor Winkhaus on the subject of "Safety Explosives." He said the efforts of manufacturers to render their explosives less and less dangerous in the presence of fire-damp and coaldust were all directed to the one end of reducing as much as possible the temperature of the gases evolved on explosion—that is, the so-called temperature of detonation. It was sought to effect this in one way by mixing high explosives, such as dynamite, with substances containing water in mechanical or chemical combination, and with easily-vaporizing substances, whose vaporization and decomposition was intended to capture a part at least of the heat evolved on explosion. Among the substances thus used were damp sawdust, soda-crystals, sulphate of magnesium, carbonate of ammonia, &c.; and these mixed in various proportions with kieselguhr constituted the so-called wetter-dynamite. To this group also coal-carbonit belonged. Another way of reducing the temperature of the gases evolved on explosion consisted in making the explosives of such substances as had of themselves a relatively low detonating temperature. Such were the explosives belonging to the so-called securit group, preceded as they were by the Sprengel explosives, mixtures of nitrated hydrocarbons with nitric acid. In practice only the first of these latter were in actual use; they were invented by Dr. Schoeneweg, a pharmaceutical chemist at Dudweiler, and consist mainly of intimate mixtures of nitrate of ammonium with the nitro-compounds of the aromatic hydrocarbon series, or with non-nitrated carbonaceous substances. Among these may be reckoned the multifarious explosives, so many of which had recently been brought out—securit, roburit, westfalit, dahmenit, dahmenit A, progressit, rhenalit and the Cologne-Rottweiler safety blasting powder. (A table accompanied the paper giving the composition of these different explosives so far as it had been possible to obtain them in the course of the investigations carried out in the experimental gallery of the Westphalian Miners' Provident Society).

The writer then refers to the definition of a safety explosive, and mentions that in France regulations are laid down as to the properties which must characterize any explosive intended for use in fiery or dusty mines, and only such explosives as yield a temperature of detonation not exceeding 1,500 degs. Cent. (3,212 degs. Fahr.) are allowed in working coal, and 1,900 degs. Cent. (4,000 degs. Fahr.) in working stone. In accordance with statements set forth in an appendix, this temperature must be calculated from the various constituents of the explosive, and in order to make that calculation possible the explosive must be enclosed in a cartridge which bears on its cover an indication of the character and quantity of the said constituents. Personally the writer does not consider it possible to express numerically such a standard of safety for an explosive as will imply its absolute harmlessness in all circumstances, and he fails, moreover, to see that such is needed. Sooner or later in all fiery and dusty mines only such explosives will be used as would be shown by the results obtained in various experimental galleries to possess an unquestionably high degree of safety. After dealing with the manner in which the conditions of the mine differ from those of the experimental galleries, the writer says if the values obtained in experiment are made use of in practical work they must be revised in accordance with the results of actual experience in the mine. The remainder of the paper deals with the experiments made with various explosives, and extensive tables are given showing the results obtained.

* * *

THE BANKET FORMATION AT JOHANNESBURG, TRANSVAAL.—A paper on the above subject was recently read by Mr. A. R. Sawyer before a meeting of the members of the Federated Institution of Mining Engineers, England. The aim of the writer of the paper is to establish four conclusions, and his claims and arguments are so novel and startling that you are struck with the daring of the man that ventures to diverge from the lines of all the favorite theories of his time.

First conclusion: The Banket formation at the end of the period of its complete deposition consisted of a series of coarse sandstones and conglomerates 10,000 feet in thickness, and covered the whole of South Africa. Further he claims that in the order of time the Banket formation was of the age of the old red sandstone, and that the enormous supply of detritus for the deposition of this thick and widely spread mass, was derived from an immense mountain system that is now submerged with the floor of the Indian Ocean. This is a great conclusion, but it is not without collateral evidence, because he notices the wide diffusion of its outliers, and the faultations and depressions and elevations in them that account for both the portions of the rock masses that remain, and those that have been denuded.

Second conclusion: The overlapping of the strata and the common direction of the lines of force by which the strata has been crumpled, and the direction of the planes of faulting, all support the conclusion of the first claim, that the detritus came from the site of the Indian Ocean, and that the folding of the Banket series was the result of a force directed also from the same region.

Third conclusion: The gold in the reefs and their leaders, found in the Banket rocks in the vicinity of Johannesburg, seem to have had an electrolytic origin, and to prepare the minds of his judges for his conclusions he supports them by further arguments, and cites a novel experiment made by Mr. Andrew Crosse. A porous pot filled with kneaded clay was placed in a vessel of water, and funnels were stuck in the clay and filled with various metallic solutions. The clay was then connected with the negative pole of a small voltaic battery, and the porous pot containing the clay was next set in an outer vessel filled with water, and this water was then connected to the positive pole of the battery. After two years had passed cracks began to be formed in the clay, and various minerals were artificially produced within the fissures, and it was observed that the electric current caused the water from the outside vessel to circulate through the fissures, and to rise to the top of the clay. He claims what all know right well is incontrovertible, namely, that the artificial depositions of metal by electrolysis, or the accidental depositions of metal on the outer sheating of ships, are only the analogues of natural depositions on a grander scale, and this he sustains in a wonderful way in his

Fourth conclusion, by showing that the deposition of the precious metal always occurs in the interstices of coarse grained rocks, such as pebbly quartz or conglomerates, and especially the coarse grained conglomerates of the Banket series in the Transvaal, for it is through the partings of such rocks, that the solutions can circulate that are subject to the electrolytic deposition, and he finds that as a general rule, but not an invariable one, the best deposits are found in the larger boulder conglomerates, instead of those of the smaller shingles. The subject is to the observing miner, that loves his geological sequences, one of the most practical interest.

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MEASURING THE PRESSURE OF GAS IN COAL AT LIEVIN COLLIERY.—The following is a translation that appeared in a recent issue of the *Colliery Guardian*, and it is taken from a communication to the *Annales des Mines*, France.

Although no sudden outburst of gas has occurred at the Lievin colliery, the coal is impregnated with a considerable quantity of fire-damp; and it appeared interesting to make some observations, as to its pressure, in the nature of those communicated by other observers. At the beginning of 1893 some experiments were undertaken in No. 1 seat of working; and the results are here recorded, with the view of adding to the general store of knowledge on the subject, although the number of experiments is too slight for permitting any definite conclusions to be drawn from them.

Arrangement of the Experiments.—Holes 6 cm. (2 in.) in diameter and of variable depth were bored in the seam by a hand drill; and a flexible copper tube, 1 cm. (0.39 in.) inside diameter, was introduced into each hole, leaving about 20 cm. (7⅞ in.) between its inner end and the bottom, while its outer end was put in connection with an ordinary pressure-gauge or a gas meter. The annular space between the tube and the hole was stemmed with damp clay, which constituted a strong tamping terminating outside at the mouth of the hole, but leaving a variable distance between it and the bottom. The thrust of the tamping was received by a wrought iron collar brazed to the pipe, a few india rubber rings being interposed between the clay and the collar. A copper pipe has this advantage over one of iron, as generally used, that it may be introduced into the hole in a single length, on account of its flexibility, whereas iron pipes are rigid, and must be used in 2 m. or 3 m. lengths (the joints of which may leak), because of the often slight distance between the face and the opposite wall. The stemming was effected by a special rammer following the form of the tube. The clay gave good results, leakage being rarely noticed; but it has the disadvantage of causing difficulty if occasion should arise for drawing the tamping, which becomes necessary if the hole has to be deepened after an observation.

For reading the pressures, a Bourdon gauge with large dial was used, and both mercury and water gauges had been prepared, although they were not used, because the pressures observed always exceeded 1 kilog. per square centimetre (14 lb. per square inch). The volumes of gas issuing from the holes were measured by a gas meter giving indications in cubic decimetres (1 cubic decimetre = 61 cubic inches).

Selection of Places for Experiments.—As all the seams in Lievin No. 1 seat of working are fiery, and almost equally so, it did not much matter what seams were chosen for the experiments. At the level of 475 m. (260 fathoms), where the experiments were made, the split return-air currents showed fire-damp contents not differing greatly one from another for the same state of the workings. It was, however, important to determine the position of the field of experiment with reference to the state of working; and in this respect two separate series of experiments were carried out—the first in a district where working had not been commenced, so that there was no doubt of the coal being hard and compact, and the second in one where the measures were fissured by neighboring workings.

"What influence," asks the author, "is exerted on the pressure and volume of gas by the depth of the tamping—or, in other words, the vacant space at the bottom of the hole?" All the experiments, he continues, show that pressure increases with the depth, so that there is the maximum pressure when the tamping reaches to nearly the bottom of the hole; and in proportion as the tamping is far from the bottom, a pressure is encountered so much the less, for an equal area of disengagement, as the permeability is greater. The results attained in the Frederic seam warrant the conclusion that the coal there is not particularly permeable, and that the pressures observed for the four holes are not much lower than what would have been found at the bottom. As regards the volume of gas disengaged, it is, for a given pressure, proportional to the area of the vacant space at the bottom of the hole.

The Pressures Measured.—On February 7, 1893, a hole 12 m. (39ft. 4 in.) deep, was put in between No. 2 *bis* and No. 4; and a space of only 1 m. (3 ft. 3⅜ in.) was left between the bottom of the hole and the tamping. This hole, No. 6, when compared with No. 4, gives an idea of the influence exerted by the position of the tamping in holes of equal depth. Other things being equal, arranging the tamping 7 m. (23 ft.) further from the bottom of the hole only altered the pressure by 1 kilog. per square centimetre (14 lbs. per square inch). The following table summarizes the particulars of the five holes, No. 1 having, as already stated, been abandoned on account of its leaking, and No. 2 having been plugged for the same reason:

Hole.	Total length. Metres.	Length of tamping. Metres.	Length of space. Metres.	Disengagement area. Sq. m.
No. 2 *bis*	9.25	4	5.25	1
3	9.25	4	5.25	1
4	12.00	4	8.00	1.52
5	12.00	4	8.00	1.52
6	12.00	11	1.00	0.19

Each hole was provided with a pressure-gauge; and daily observations were made regularly up to April 15, *i. e.*, during a period of three months, at the end of which the pressure was not appreciably diminished. Only one hole, No. 4., showed any considerable diminution of pressure, viz., 1.5 kilogs. per square centimetre (21 lbs. per square inch), which is explained by the fact that the gas was allowed to flow through the meter from the 5th to the 25th March. Two years after these observations, in March, 1895, without the arrangements having been in any way modified, the following particulars were noted:

Hole	Pressure in kilogs. per sq. cm. In March 1893.	In March 1895.	Diminution of pressure. In Kilogs. per sq. cm.	In lbs. per sq. in.
No. 2	5.5	4.2	1.3	18½
3	4.2	2.5	1.7	24
5	5.7	3.75	1.95	27

General Results.—The maximum pressure observed at Lievin was 7.5 kilogs. per square centimetre (105 lbs. per square inch) in a hole 12 m. (39 ft.) deep, whereas the maximum in England was found by Mr. Lindsay Wood to be 31 kilogs. per square centimetre (441 lbs. per square inch) and in the Couchant de Mons, Belgium, 42.5 kilogs. per square centimetre (604 lbs. per square inch), while at the Treuil Colliery, Saint-Etienne, they were found to be less than at Lievin. The observations made in the Frederic and Alfred seams of that colliery show that fire-damp is not regularly distributed through the mass of coal. The pressure increases with the depth of the holes, which is self-evident, and confirmed by all the experiments; but the results obtained at Lievin do not coincide with those of Mr. Lindsay Wood, nor do they bear out Mallard's formula.

The heading in the Frederic seam only drained the gas very slowly, since, after more than two years, the pressure was only reduced by one-third at the outside. It would therefore appear that, for draining off fire-damp, headings which cause no subsidence are but slightly efficacious, and this also explains why the utility has so often been questioned of holes for draining the seam of gas. Mallard considered that the volume increases with the pressure; but the author (M. A. Simon) found that, for equal pressures, the volume per unit of disengagement area was fifty-six times greater in the Alfred (disturbed) seam than in that of Frederic (undisturbed.)

Must Not Hold Public Office.

In accordance with an order recently issued by the Superintendent of the Philadelphia and Reading Coal and Iron Co., all persons occupying official positions under this company must not hold or become candidates for election to public office. This order applies only to township offices. An inside foreman and a fire boss in the Heckscherville valley both received nominations for township offices at the recent primaries, but were obliged to withdraw from the contest. During the presidency of the late Franklin B. Gowen no employe of the company was permitted to hold any public office.

ANTHRACITE STATISTICS FOR 1895.

From advance sheets of the Reports of the Inspectors of Mines of the eight anthracite districts of Pennsylvania, we are enabled to compile the following tables, which will be found to contain a complete summary of the usual statistical reports. For purposes of comparison the statistics for 1894 are also given. This is the first time the complete statistics for the anthracite districts have ever been published in this form, and so soon after the close of the year. The credit for the compilations is due Mr. Baird Halberstadt, mining engineer of Pottsville, Pa., our special representative for the anthracite regions:

Table Showing Total Production, Shipments, the Increase in Production in 1895 Over That of 1894, Number of Employes, Fatal and Non-Fatal Accidents, Kegs of Powder and Pounds of Dynamite Used, Number of Horses and Mules, Number of Steam Boilers in Use, Tons of Coal Mined Per Life Lost and Per Non-Fatal Injury, in the Anthracite Collieries in 1895.

District.	Total Production. (Tons.)	Total Shipments. (Tons.)	Production Increase Over 1894. (Tons.)	Persons Employed.	Fatal Accidents.	Non-Fatal Accidents.	Kegs of Powder.	Pounds of Dynamite.	Number of Horses and Mules.	Number of Steam Boilers.	Tonnage per Life Lost.	Tonnage per Non-Fatal Injury.
First	6,510,817	6,216,937	663,696	16,272	39	121	220,462	—	1,468	554	166,944	53,808
Second	6,189,496	5,613,174	514,957	16,269	34	192	219,357	—	*1,465	*550	182,044	32,237
Third	6,214,834	5,719,076	687,882	17,413	69	167	206,906	—	1,990	773	90,070	37,215
Fourth	8,066,412	7,194,895	903,451	24,572	74	221	212,843	—	2,730	1,204	109,005	36,500
Fifth	6,950,998	5,788,702	458,371	18,465	53	96	109,307	—	1,991	1,477	131,151	72,406
Sixth	7,164,895	6,636,166	824,261	19,814	59	85	157,461	335,895	1,929	1,368	124,825	47,758
Seventh	6,184,542	5,715,620	779,719	19,399	59	114	139,193	168,719	2,146	1,004	104,823	54,250
Eighth	3,925,013	3,672,873	583,028	11,406	35	124	55,157	315,177	1,258	773	112,143	31,631
Totals	51,207,007	46,557,443	5,356,005	143,610	422	1,120	1,320,686	819,791	15,377	7,503	†121,344	†45,721

Comparative Table Showing Total Production and Shipments of Coal, Fatal and Non-Fatal Accidents, and Tonnage Per Life Lost and Injury in 1894.

District.	Total Production. (Tons.)	Total Shipments. (Tons.)	Fatal Accidents.	Non-Fatal Accidents.	Tonnage per Life Lost.	Tonnage per Non-Fatal Injury.
First	5,907,331	5,692,644	47	98	125,686	40,746
Second	5,674,539	5,195,272	41	141	138,404	40,245
Third	5,541,952	5,217,199	51	148	108,665	37,445
Fourth	7,162,961	6,856,810	77	233	93,025	30,742
Fifth	6,132,627	5,313,100	58	95	105,735	64,554
Sixth	6,340,631	5,888,300	73	94	86,858	67,453
Seventh	5,404,823	4,973,335	78	76	69,293	71,116
Eighth	3,341,315	3,088,794	29	40	167,066	83,533
Totals	45,506,179	42,225,454	445	925	†102,261	†49,196

*Estimated. †Average.

Table Showing Causes of Accidents, Number Attributable to Each, and Total Number of Fatal and Non-Fatal Accidents at Anthracite Collieries in 1895, with a Comparative Table for 1894.

1895.

Cause of Accident.	1st District.		2d District.		3d District.		4th District.		5th District.		6th District.		7th District.		8th District.		Totals.		Percentages.	
	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.
Explosions of gas	—	9	—	6	4	34	10	45	1	9	10	15	3	16	3	30	31	164	7.35	14.64
Falls of roof and coal	22	54	23	87	30	41	33	65	24	39	24	26	23	40	12	22	191	374	45.26	33.39
Falling down slopes, shafts, etc.	—	—	—	2	3	—	2	—	1	—	4	—	2	1	2	3	14	6	3.32	0.54
Explosions of powder, blasts, etc.	5	19	4	29	6	23	13	38	7	7	8	11	9	10	7	8	59	145	13.98	12.95
Crushed by mine wagons, machinery, etc.	7	20	5	41	12	44	5	21	13	28	4	22	14	36	6	31	66	243	15.64	21.70
Miscellaneous underground	3	15	2	20	2	19	7	32	3	5	9	11	8	11	5	30	61	188	14.45	16.78
Miscellaneous on surface	2	4		7	12	6	4	20	4	8										
Totals	39	121	34	192	69	167	74	221	53	96	59	85	59	114	35	124	422	1,120	100.00	100.00

1894.

Cause of Accident.	1st District.		2d District.		3d District.		4th District.		5th District.		6th District.		7th District.		8th District.		Totals.		Percentages.	
	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.
Explosions of gas	—	2	—	14	2	24	7	33	1	1	12	22	6	8	1	5	29	109	6.51	11.79
Falls of roof and coal	30	39	23	51	22	42	44	68	21	34	23	23	27	30	6	10	196	297	44.05	32.11
Falling down slopes, shafts, etc.	3	1	—	1	4	3	2	—	—	—	2	2	6	2	1	—	18	9	4.05	0.97
Explosions of powder, blasts, etc.	2	16	4	25	3	15	4	23	15	11	6	11	9	3	—	9	43	113	9.66	12.21
Crushed by mine wagons machinery, etc.	10	29	7	41	13	38	7	59	15	31	7	20	13	27	5	9	77	254	17.30	27.46
Miscellaneous underground	—	3	5	7	4	14	6	23	4	2	9	8	8	2	3	—	39	59	8.77	6.38
Miscellaneous on surface	2	8	2	2	3	12	7	27	2	16	14	8	9	4	4	7	43	84	9.66	9.08
Totals	47	98	41	141	51	148	77	233	58	95	73	94	78	76	29	40	445	925	100.00	100.00

LEGAL DECISIONS ON MINING QUESTIONS.

(Reported for THE COLLIERY ENGINEER AND METAL MINER.)

Dangerous Appliances—Blasting.—In an action by an employe for injuries caused by a premature explosion of dynamite while blasting, where it was shown that the company knew that the tools furnished the employe were unsuitable and dangerous, and the evidence to contributory negligence was conflicting, a verdict against the employer will not be disturbed by the court on appeal.

Ohio Valley Ry. Co. v. McKinley (Ct. App. Ky.) 33 S. W. Rep. 186.

Negligence in Blasting.—Blasting by "breasts" or rows of holes from 14 to 20 feet deep, charged with dynamite, and simultaneously exploded, making blasts so powerful that the surrounding earth for a considerable distance was shaken, and logs placed on the blast were thrown 200 feet, and over the tops of houses, shows a want of due care and regard for the interests of others on the part of the operators, for which they are liable, where it appears that the work could have been accomplished by smaller blasts, though not so expeditiously. The method adopted was the one usual for excavating rock, and the one most profitable to the operators; but it is very evident that in conducting the work they had regard only to their own interests. Reasonable care, however, required a due regard for the interests of the adjoining property owners.

Newell v. Woolfolk (Supreme Court 2d Dept.) 36 N. Y. S. Reporter, 327.

Contract for the Manufacture of Mining Machinery.—A contract for the sale of a mining and pumping plant to be manufactured in accordance with special specifications, which require the furnishing of special engines and pumps, connected by shafting specially fitted, the specially manufactured parts of which would be of little value except in connection with the plant, is not within the statute of frauds, requiring contracts to be in writing, etc., though the bulk of the plant was made up of articles purchased as merchandise by the seller from other parties.

Puget Sound Machinery Depot v. Rigby (Supreme Court, Washington) 43 Pacific Reporter, 39.

Inspection of Roofs and Use of Props in Mines.—The Supreme Court of Iowa recently said: The evidence shows beyond all question that there are many places in the roofs of mines that do not require props or supports, because of the roofs being composed of slate or stone. But there is evidence tending to show that such places in the roofs, by lapse of time, may become dangerous and require props. It appears that the mining company was in the habit of making daily inspection of the roof by tapping it with the dull end of the pick. Whether daily inspection was required, we do not determine. Of course, we do not hold that the fact that the roof was not propped at the place of the accident authorizes a recovery. The men working in the mine know that props are only used where they are thought to be necessary, and by their employment they take the risk of the service with the roofs in that condition, but with the obligation of the operators to make proper inspection of the roofs, and to remedy defects in it. But where the testimony in a personal damage case as to whether a miner was injured through his own negligence in blasting and removing coal, or through the negligence of the company in not properly caring for the roof, the issue should be left to the determination of the jury.

Morris v. Excelsior Coal Co., 64 N. W. Reporter, 627.

Contracts as to Oil in Land.—A contract recited that the first party granted to the second party "all the oil and gas in and under" certain premises, "together with the right to enter thereon at all times for purposes of drilling and operating for oil * * * and to erect all buildings * * * and lay all pipes necessary to the production and transportation of oil or gas taken from said premises. Excepting and reserving to the first party one-eighth of all the oil produced, * * * to be delivered in the pipe line with which second party may connect his wells." First party "leases one acre anywhere out of this above described land for a test well, and if oil or gas is found, then second party has the balance of the above land to drill at the same royalty as the within lease. To have and hold said premises on the following conditions: If gas only is found, first party is to receive $100 for each well." Second party "agrees to commence operations within 30 days, and to complete a well in 30 days" thereafter, and failing therein, is to pay first party annually $5 per acre till said well is completed. The court held that the right granted was absolute to take all oil and gas under the entire tract, and that failing to make the test well, $5 per acre thereof was to be annually paid to the first party.

Columbian Oil Co. v. Blake (App. Court, Ind.) 42 N. E. Rep. 234.

Measure of Damages in Failing to Make Mining Operations.—Where, in consideration of extension of time to pay purchase money of mining property, the buyer gives notes secured by deed of trust on the property, and agrees with the seller that he will, till the payment of the debt, work the mine in mine fashion, the measure of damages for breach of such contract, for which the seller only has a cause of action, is the injury to the security.

Belmont Mining and Milling Co. v. Costigan (Supreme Court Colo.) 42 Pacific Reporter, 647.

When a Court of Equity Will Not Interfere With Mining Proceeds.—Certain parties entered into a contract with a mining company whereby they conveyed to the latter a perpetual easement and right of way through a tunnel upon certain mining claims belonging to them, to be used by the company in developing and working its own mining properties, etc., in consideration of a cash payment "and the residue out of the proceeds of the first ore shipped from the company's property." The company not fulfilling its contract, the parties filed a bill in chancery praying for a temporary injunction restraining the company from using any money payable to it for ore, except for the purpose of paying them the amount due, and for a decree making the injunction mandatory, by requiring the company to pay them the first money received by it for ore, within the limitation of the contract. The court held that there were no words in the agreement which could operate to transfer any specific fund, or an interest in any specific fund. No right was conferred upon these parties to receive the money, except as it might be paid to them by the company. The ore belonged to the company. It extracted, shipped and stored it, or sold it, and when it received the price of its ore, the proceeds were its own. The agreement gave these parties no interest in the money as such. It was simply a promise by the company that, when it received the money, it would apply it on the payment of the debt; and until it should do so no title in the money could pass to these parties. If it failed in the fulfillment of its promise, their remedy was an action at law against the company for breach of contract. In other words, a promise to pay a debt out of proceeds of ore to be mined is not an equitable assignment of such proceeds, and a court of equity will not enforce the agreement.

Silent Friend Mining Co. v. Abbott (Ct. App., Colo.) 42 Pacific Reporter, 318.

Agent or Attorney May Locate Mining Claim.—An agent, or attorney in fact, may locate a mining claim for his principal, and may do everything necessary to perfect such location, including the making of the affidavit required by the laws of Idaho.

Dunlap v. Pattison (Supreme Court Idaho) 42 Pacific Reporter, 504.

Risk of Employment—Mining.—On a trial in the Circuit Court of the United States, it appeared that one T. was the foreman of a mine, which was owned by a corporation having large interests in various places under the general charge of a superintendent; that T. had power to hire and discharge the men, direct their work, and generally to control all the ordinary operations at the mine, and upon one occasion, upon the complaint of F., had promised to remove a dangerous obstruction in the tunnel, and had afterwards caused it to be removed. There was evidence that F. had complained to T. of the dangers from the projecting bolts on the revolving shaft, and that T. had promised, a few days before the accident, to have the coupling covered with a box for protection. The Circuit Court of Appeals held that it was within the apparent scope of T's authority to promise to make the coupling safe, and that F. did not, by continuing in the company's employment in reliance on such promise, assume the risks arising from the dangerous condition of the coupling. Also, that the rule that an employer is not bound to replace an appliance, such as is in common use, because it is possible to get a better one, did not apply to relieve the mining company from the duty of protecting the exposed coupling as promised.

Homestake Mining Co. v. Fullerton, 69 Federal Reporter, 923.

Who Cannot be Served as Official Representative of Mining Company.—The Supreme Court of South Dakota holds that, an attorney in fact (one created by deed) authorized by a mining corporation to apply for a patent to mining ground claimed by it and to execute such papers as may be necessary for that purpose, is not by virtue of such employment a "managing agent" within the meaning of the statute of that state in relation to service of process upon corporations.

Mars v. Oro Fino Mining Co. 65 N. W. Reporter, 19.

What is Included in Deed to Minerals.—The meaning of the words "minerals" and "ores" in a deed cannot be limited or explained by declarations of the parties as to what was intended, to be covered by the deed, when reformation of the same is not sought.

Though the words minerals and ores in a deed, standing alone, would include granite, where the surface rights granted are only sufficient land to erect suitable buildings for machinery and other buildings necessary and usual in mining and raising ores, they will be held to include only minerals obtained by underground working.

Armstrong v. Lake Champlain Granite Co. (Court Appeals, N. Y.) 42 N. E. Reporter, 186.

Questions of Negligence Must Be Determined by the Jury.—Where, in an action for personal injuries to a miner, there was evidence that the superintendent of the company knew of a loose stone over the place where the miner was put to work by him, and that the superintendent had made an unsuccessful attempt to dislodge it, and that he told the workman of that fact, and that the place was safe, but the stone afterwards fell upon the workman, the question of the company's negligence and the employe's want of care is for the jury. As is also the question of whether the employe assumed the risk.

In such an action it is not competent to show that no accident had ever happened there before that.

Burgess v. Davis Sulphur Ore Co. (Supreme Judicial Court, Mass.) 41 N. E. Reporter, 501.

Contract of Conveyance of Mineral Rights.—An instrument conveying the mineral interest in certain land, after reciting a nominal consideration, declared that the grantee should have full power to convey, and the grantee stipulated that he would examine the land and if he found valuable minerals, would pay the grantor one-half the net proceeds of same, or should such grantee convey to third persons he would pay the grantor $200, and one-half the net proceeds of the sale. The Supreme Court of North Carolina held that the rights of the grantee under such an instrument were forfeited by his failure, for eight years, to open the mine, and prepare it for sale. Also, that where a conveyance of mineral rights in land is defeated by the grantee's failure to perform the particular acts stipulated to be done by him in the instrument itself, and which forms the real consideration for its execution, a re-entry by the grantor is unnecessary.

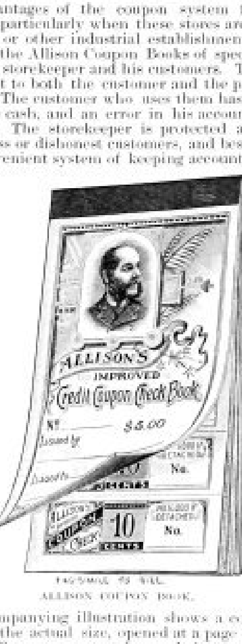
Hawkins v. Pepper, 23 S. E. Reporter, 434.

Sufficient Description of Premises for Mining Lien.—Where the same persons own two mining claims only one of which has improvements on it and it appears that the mines are known by the names of the parties working them, a notice of lien reciting that it is for work done within a designated period of three months on a mining claim, with improvements, located in a particular mining district of a certain county, owned by the persons (naming them) who had the work done, does not identify the claim with the improvements with sufficient certainty to creat a lien upon such property. The description must be such as will enable one to identify the mining claim to the exclusion of any other premises. An incorrect description in a notice renders such notice invalid.

Fernandez v. Burleson (Supreme Court, Cal.) 42 Pacific Reporter, 566.

Allison's Coupon Books.

The advantages of the coupon system for general stores, and particularly when these stores are connected with mines or other industrial establishments, are such as to make the Allison Coupon Books of special interest to both the storekeeper and his customers. These books are a benefit to both the customer and the proprietor of the store. The customer who uses them has practically the same as cash, and an error in his account is an impossibility. The storekeeper is protected against loss from careless or dishonest customers, and besides he has a most convenient system of keeping accounts.



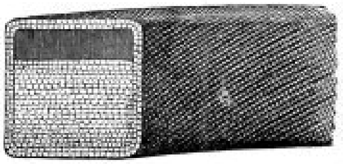
FAC-SIMILE 3/5 SIZE.
ALLISON COUPON BOOK.

The accompanying illustration shows a coupon book three-fifths the actual size, opened at a page of ten cent coupons. The coupons can be made in any denominations from one cent up. The method of using them and keeping exact accounts is very simple and easy. In fact by their use the least possible amount of book-keeping is required. To really appreciate the Allison coupon book it should be examined and the directions for its use read. These directions are not complicated in the least and can be readily understood by any man able to count money. A sample book and a very small pamphlet showing the advantages of the system are sent free to any person interested, on application to the Allison Coupon Co., Indianapolis, Ind.

Garlock High Pressure Packing.

It is but a few years ago that steam at six atmospheres was considered a high pressure and was about the limit on steam plants. To-day on the modern steam plants, with triple expansion or compound engines 150 pounds is a common pressure, and on many of the larger engines a pressure of 225 pounds is used.

The Garlock Packing Co., ever alive to the requirements of the times, have produced a High Pressure Packing, made of selected fibre and metal, in combination with the celebrated Garlock packing compound, which has successfully withstood the trials and hardships of stuffing box life on the largest engines for many years.



GARLOCK HIGH PRESSURE PACKING.

This packing is especially adapted to high pressure work on locomotives, stationary and marine engines. The construction is without question designed to *insure long service*.

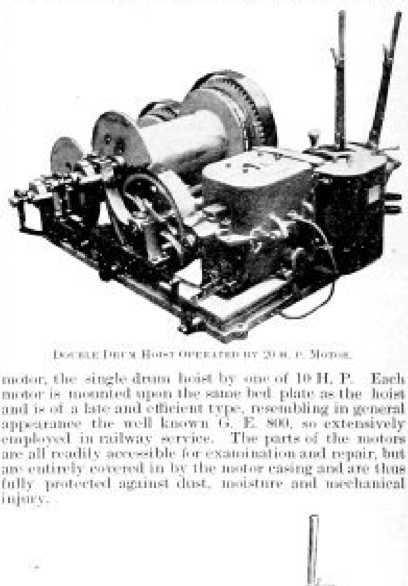
The method of guaranteeing this packing is to ask customers to try it and judge for themselves.

If you are in want of a high pressure packing send for sample.

Made in sixteenth and eighth sizes from ¼ in. to 2 in. square.

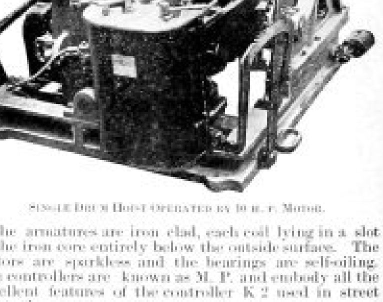
Electric Portable Hoists.

The application of the electric motor to portable hoists for derricks is illustrated admirably in the two hoists which the General Electric Company has lately furnished the United States Government, in connection with an important electrical installation. These hoists are of the double drum and single drum type respectively; the double drum hoists being operated by a 20 H. P.



DOUBLE DRUM HOIST OPERATED BY 20 H. P. MOTOR.

motor, the single drum hoist by one of 10 H. P. Each motor is mounted upon the same bed plate as the hoist and is of a late and efficient type, resembling in general appearance the well known G. E. 800, so extensively employed in railway service. The parts of the motors are all readily accessible for examination and repair, but are entirely covered in by the motor casing and are thus fully protected against dust, moisture and mechanical injury.



SINGLE DRUM HOIST OPERATED BY 10 H. P. MOTOR.

The armatures are iron clad, each coil lying in a slot in the iron core entirely below the outside surface. The motors are sparkless and the bearings are self-oiling. The controllers are known as M. P. and embody all the excellent features of the controller K 2 used in street car work.

The levers for the brakes, controllers, etc., are so arranged that full control of the entire mechanism is had without change of position by the man in charge.

The hoists themselves are from the works of the Lidgerwood Company. The drums are 14 inches in diameter and 26 inches long.

One of the early difficulties with steel pens was the stiffness, which Perry removed in 1830, by perforating the pen at the top of the slit, an improvement very valuable for producing "soft pens."—*Electric Power*.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

CHEMISTRY OF MINING.

The Diffusion of the Light of a Safety Lamp—The Correct Elevation for the Light—The Correct Angle of Diffusion—The Diameter of the Glass Cylinder—The Lamps Miners Prefer—Refraction of Light—Good Light in Safety Lamps.

89. **The Diffusion of the Light of a Safety Lamp.**—This is a matter of prime importance and there can be no doubt concerning the enhanced value of a lamp in which the right angle for the diffusion of the light has been provided.

The writer has seen lamps that were faultless, in so far as the insulation of the flame and the simplicity of the details of construction were concerned, rejected by mine foremen and superintendents after they had tried them, and found they "did not like them because they gave a bad light." "Bad light" does not refer here either to the qualities of the oil or the wick, but to the angles of the diffusion of the light. It may be said with assurance that no miner likes a lamp he has to raise to the level of his face to see his friend's eyes, and he always does so with a twitch of anger, for his feelings say: "This is a horrible lamp."

It is remarkable, that too little attention has been given to the investigation of the principles of action of the lighting fittings of the safety lamp, and the result is, many of the details are wrongly proportioned, and this is especially so in the case of the glass cylinder, for we find it too short, too wide, the glass shell too thin, and the flame within it set at the wrong elevation. It is true the proportions are better in some makes of the lamp than in others, but in many, as we all know, the proportions are unfavorable to the production of a good light. For example, different makers of the Marsaut lamp give different lengths and thicknesses to the glass cylinder, and it is interesting to notice how these variations affect the acceptance of the different productions; and stranger still, is the fact, that in the judgment of the different lamps you invariably find practical men come to the right conclusion although they never assign any reason for their preference, yet they are right on principle, "for by their fruits ye shall know them." These men carry a lamp one shift, and they actually judge the lamp by its potential, and by them the potential is guaged by their feelings, and if they say the lamp does not please them, rest assured it is not right, for they are seldom wrong.

To prove this just examine one of the Marsaut lamps they condemn, and you will find that the wick pipe sets the flame too high or too low, or the shell of the glass cylinder is too thin, or too short, or too large in diameter, or else the frame of the lamp is made to protrude so much as to cut off a high percentage of the light, but be assured something is wrong if these men say they "do not like the lamp."

Let us then try to discover how the diffusion of the light of a safety lamp is affected under proper and improper conditions, and to begin, let us consider first:

90. **The Correct Elevation for the Light.**—We will proceed with the assistance of Fig. 128. Here it will be seen by reference to the section that the light it represented in two extreme and opposite positions, in one

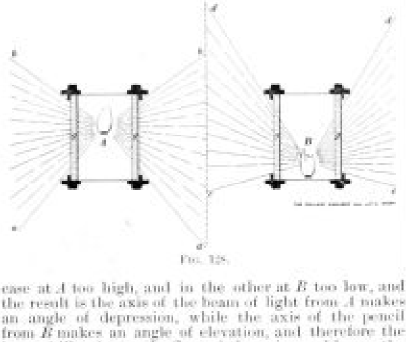


Fig. 128.

case at *A* too high, and in the other at *B* too low, and the result is the axis of the beam of light from *A* makes an angle of depression, while the axis of the pencil from *B* makes an angle of elevation, and therefore the lamp *A* illuminates the floor of the mine and leaves the roof in darkness, while *B* illumines the roof and leaves the floor in darkness. Both these elevations are, therefore, objectionable, and rather suggest that the axis of the beam of light should be in a horizontal plane, but experience teaches that the light should be thrown rather more upward than downward, and it will be noticed that the term "rather more" is not calculated to lead us to a reliable conclusion, and should be qualified by the statement of a definite value. The center of the light then should not be elevated any less or more than one-third of the height of the glass cylinder; and this statement being accepted from the teachings of experience, it suggests another provision that should be made to secure the required height of the wick pipe, and this should never exceed one-fifth of the height of the glass cylinder. Now be it understood that the height of the glass cylinder here spoken of, is not the total height, but the height through which light can pass, and which is uncovered within the flanges of the top or bottom rings that keep the glass in position. If the top of the wick pipe has an elevation of about one-fifth of the height, the top of the wick, in its adjusted position for burning the oil, must have an elevation of one-fourth of the height, and as the center of the flame will occur above the top of the wick, these proportions will bring the center of the flame to an elevation of one-third the height of the available surface of the glass cylinder, and therefore, so far as the elevation of the light is concerned these values will secure the best results.

91. **The Correct Angle of Diffusion.**—The limits of the beam of light whose axis makes an angle of elevation are for *B*, *d c*, and it will be seen that the light of *B* is more thrown upward than that of *A*, by the vertical length *d b*, and the beam of light from *A* that makes an angle of depression, is more prolonged downward than that of *B*, by the vertical length *c a*. The proportion given for the height of the top of the wick is for a short glass, but where a long glass of 3 or 3½ inches is used then the height of the wick pipe should be adjusted for the center of the light to occur at one-third the available height.

92. **The Diameter of the Glass Cylinder** greatly affects the diffusion of the light of a safety lamp, and a mere glance at Fig. 129 sustains this conclusion. It will

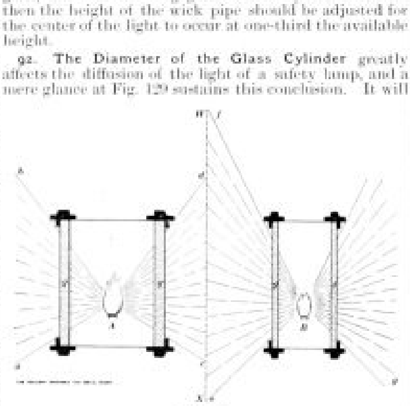


Fig. 129.

be seen by the sections before us that a wide cylinder reduces the angle of diffusion, whereas a narrow one increases this angle. The reason for this difference in the angles of diffusion is found in the fact that when the actual lengths of two chords are equal, and their radians are different, then their angles are different. Now the actual lengths of the radians of *A* and *B* are different, the result is the angle of diffusion of *B* is much greater than that of *A* in the proportions of the chords *d c* and *W X*. The actual angles of diffusion are *A* 100 degrees, and *B* 130 degrees. We cannot, therefore, set aside the fact that a greater volume of light is diffused by a lamp with a glass cylinder small in diameter, than with a lamp in which the diameter of the glass is relatively large; and another fact is of equal importance and interest in the investigation of this matter, and that is, a short cylinder of small diameter will diffuse as much light as a longer "glass" with a larger diameter, because if the radius of a small glass is one inch and its disposable height two inches, the angle of diffusion will be the same as that of a glass 1.5 inches in the radius and three inches in available height, therefore, when we assign any diameter to the glass cylinder of a lamp, we cannot do otherwise than co-relate the diameter with the length. Looking at many makes of the lamp, we are struck forcibly with the impression that the glass is *short*, and that there must be, or has been, some particular reason for this and other defects in the construction of the safety lamp in so far as its potential of illumination is concerned, and digressing for a moment, let us notice that the word *potential* here used, has in relation to the lighting *power* of the lamp a very significant meaning; for example, lights are of high and low tension, or if you please, of greater and lesser intensity, and another factor of a light is its volume. Now in mechanics if you multiply the pressure by the volume, the product is the power, so if you multiply the intensity of a light by its volume, you obtain its *potential*.

93. **The Lamps Miners Prefer.**—Again, let us come back to the consideration of the practical reason for the shortening of the glass cylinder of a safety lamp. Practical miners have been heard to say, and how often have we said the same ourselves, "Give me a Davy lamp to test for gas," and this special preference was the reason of the Clanny gauze and the Clanny glass being both made as short as possible, because the shorter these parts were made, the better was the lamp adapted for immersion in a stratum of gas floating under the roof of the chamber, and the result was a *short* lamp was said to be very *sensitive*. What is true of the Clanny is equally true of the Marsaut, but now with improvements, such as we find in the Gray lamp, a stratum of gas only one inch in depth can be detected under the roof, as the air to feed the flame at the period of testing has to pass down tubular poles *a b* and *c d* shown in Figure 130. This lamp is bonneted, and when used for other than testing purposes, the down-flow of air through the poles is cut off, and the supply of air is then admitted near the bottom of the air tubes, and strange to say, as seen in the figure, the glass cylinder is here lengthened, with the object of showing the gas cap on the flame, but as the only object of this elongation of the glass is to show the "blue tail," the conical glass is so fixed that it cannot increase the diffusion of the light.

Fig. 130.

In fixing what should be the dimensions of the glass cylinder, there are several great principles that should guide us; and for the present, let us notice two of them. First, then, the glass should be as long as possible, and the diameter as short as possible. Or the length of the glass shell should be 1½ times its diameter.

Having given attention to the diameter and length of the glass cylinder of the safety lamp, a principle of construction of equal importance confronts us and demands an answer, and it is this: What should be the thickness of this glass shell?

As we cannot evade the question, we must provide an answer, and the reader must assist us with his forebearance while we try to make interesting a problem that is somewhat involved, for we have now to consider the refraction and interference of light in relation to the practical requirements of the miner. However, "to patience and faith the prize is sure," and with the help of Fig. 131 we cannot fail to secure the solution of the problem.

Light, in common with other modes of motion, is most active along the lines of least resistance in its path, and as a result of this, it is subject to refraction. For example, when light strikes a plain glass surface obliquely, the ray suddenly alters its course in passing through the glass, as in the case of the ray *a b*. It now takes the path of least resistance *b c*, and then leaves the glass nearly parallel to its course at the moment of incidence; that is to say, *a b* is parallel to *c d*.

There is much that might be said about refraction, if we were treating on physical science alone, but our subject is lamp glasses, and we, therefore, only require to know for the present how the refraction of light effects our subject.

The reader should, however, make himself familiar with the effects of refraction, such as are within his reach, to enable him to better understand this subject. For example, light cannot pass through air without resistance, and therefore refraction as found in the atmosphere where the sun's rays have to pass through different depths and densities of the atmosphere. Water, however, furnishes the most convenient illustration for our present purpose, and all can practice the experiment here introduced.

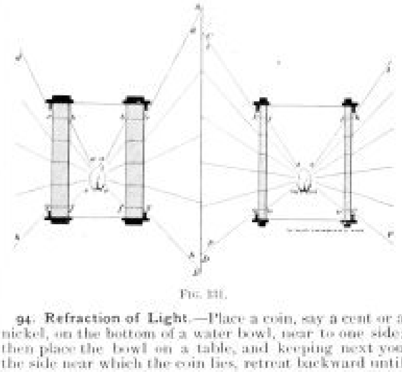


Fig. 131.

94. **Refraction of Light.**—Place a coin, say a cent or a nickel, on the bottom of a water bowl, near to one side; then place the bowl on a table, and keeping next you the side near which the coin lies, retreat backward until the top edge of the bowl just conceals the coin. While standing here, let an assistant gently pour water into the bowl, and as the surface of the inpoured water rises, the coin will come more and more into view, until the coin and the bottom of the bowl will appear to have been upraised. Now we have here an example of an invisible body being rendered visible by the refraction of the reflected light from its image in passing through water, and indeed what here takes place is the analogue of the increase in the angle of diffusion of the light of the safety lamp. Having made clear what we mean by refraction, we have now to consider the relationship of the thickness of the glass to the angle of diffusion, and

the figure is designed to furnish the required solution, and therefore we see at a glance that the thick glass gives a greater angle of diffusion than the thin one, for *m n* is parallel to *o p*, just as *e f* is parallel to *g h*; and *i j* is parallel to *k l*, just as *a b* is parallel to *c d*. The reader will find that the coin experiment sustains the same conclusion, for as the depth of the water in the bowl increases, the angle of diffusion increases, and therefore a greater depth brings the coin more into view than a less one, and in the same way we see that the chord of the arc *C D* is considerably less than the chord *A B*, or the arc due to the thick glass.

We may then conclude that the thick glass is the one best adapted to the requirements of the safety lamp, but before accepting this dictum, let us notice, a high refraction is the result of a high resistance, and a correspondingly great diminution in the intensity of the light, and therefore we can get a high angle of diffusion with a thin glass if we reduce the diameter of the cylinder. There is without a doubt a thickness at which the glass shell gives the best results, but it will require the teachings of the next lesson to furnish other facts that must figure as witnesses in the trial.

95. Good Light in Safety Lamps.—There are other matters of importance beside the thickness of the glass shell that deserve our notice, and not the least of these is the question of a motive column to bring live air to the flame of the lamp, and we must all admit that with the exception of the Gray lamp, very little has hitherto been done to obtain a motive column commensurate to the requirements of the case. On examining some of the best modern lamps the first thing that strikes us is this, little or no provision has been made for the complete combustion of the oil and we continue to say these lamps will give a bad light. As a case in point let us consider the Mueseler lamp as illustrated by Fig. 132, and here we find the only approach to a motive column is furnished by the conical funnel; but, say you, "good oil should burn like an open candle;" our reply is, so it should, but if you interpose between the flame of the candle and the open air two gauze diaphragms for the feed air to pass through, then the candle flame will pour off a column of sooty smoke and then you will admit that the naked light is best, or otherwise you must provide a motive column to overcome the resistance the air is subject to in its passage to the flame.

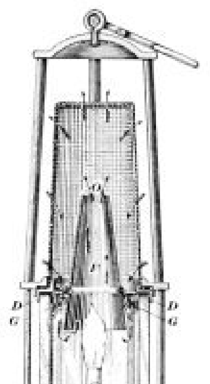


Fig. 132.

This is exactly the case in the Mueseler lamp; the air has to first pass through the meshes of the gauze cylinder, and after that it has to force a passage through the meshes of the horizontal gauze diaphragm that supports the funnel, and the result of this is, not only is the glass cylinder badly adapted for the diffusion of the light, but the conditions of combustion are under such restraint, that the light is subdued and the lamp loses favor with the miner. Let the reader observe that in the Gray lamp in its most recent form, as we find it in the United States, the air feed takes place at the bottom of the lamp, after the original idea of Stephenson, but in the case of the Mueseler the feed air enters above the glass cylinder, with the result of losing a portion of the elevation that should be disposable for a motive column.

This brings us to the consideration of the claims of the Marsaut lamp, Fig. 133. Here the motive column is a little longer, and all men who have used this and the Mueseler know, that it has been preferred for its superior light, but the air here enters as in the common type of the bonneted lamps above the glass cylinder, and in addition, the feed air has still to be drawn through the meshes of a double system of gauze walls with a great loss of motive column with the result, that all this type of lamps are easily extinguished, and give a very bad light where the air contains a small percentage of carbonic acid gas. The entering air must pass through some medium like one gauze, or better still, two gauze barriers, but some moving pressure is required to overcome the unavoidable resistance, and the only source of this factor in the feed potential of a lamp is in a motive column due to the rarefaction produced by the heat of the lamp flame. From all this and what is to follow, we have so far found, and will further know, that all future improvements in the safety lamp must conform to the requirements of a good light, as only secondary to the best provision for the perfect isolation of the flame.

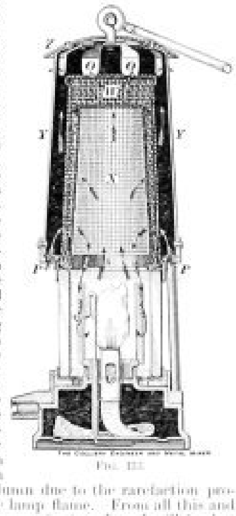


Fig. 133.

(*To be Continued.*)

MINING METHODS.

Underground Fires—Chemistry and Chemical Action—Chemical Changes of Carbon—Extinguishing Underground Fires—An Underground Fire in the Workings—The Effect of High Pressure in Gob Fires.

87. Underground Fires.—These can only be kept under subjection and ultimately extinguished by correct methods of treatment, and to explain such is the object of this and the other lessons on the subject.

Fire is a manifestation of very active chemical action, and as this action is the resultant of well known forces, it is capable of being restrained or rendered passive by cutting off the supply of one of the components of the resulting energy; for example, if while a candle is burning in a can the lid is put on and tightly closed, after the expiration of a moment or two the flame of the candle will die out, or, in other words, chemical action will cease, because combustion is the result of oxygen combining with inflammable substances, and the moment the supply of oxygen ceases, that same moment combustion ceases, because the fuel burns the oxygen as surely as the oxygen burns the fuel, and to one who has not studied the laws of chemical combination such a statement will no doubt be in conflict with his preconceived notions. To the chemist it is as correct to say that a piece of paper burns the oxygen of the air, as it would be to give the common rendering of the operation and say the oxygen burns the paper. This is proved by fixing a bracket and gas burner in a tank, and then filling the vessel with coal gas. To the burner is fixed a platinum wire, and this is put in circuit with the generator of an electric current, and the moment a current of oxygen gas or even atmospheric air is forced through the pipe and out of the burner, the same moment the electric current is turned on, when it lights the oxygen jet at the gas burner, and we now witness oxygen gas or air, burning and giving off light and heat with a veritable flame in an atmosphere of coal gas, thus fully sustaining our conclusions.

88. Chemistry and Chemical Action.—That variety of chemical action called fire is the result of certain elements combining, while in a *nascent* state, or in a state in which they actively devour each other, and produce new substances totally unlike themselves. Now the reader may think that the writer cares more for the science of chemistry, than for the suppression of underground fires, but let him wait for further explanation, and he will discover the need of these preparatory remarks. On looking back a few lines in the lesson the word *nascent* is seen, and before we proceed further with the suppression of underground fires we must know properly what this word means, and its bearing on our subject. If we mix two parts of oxygen gas with one part of coal gas, we obtain a very explosive mixture, and yet if no flame is brought into the mixture, the gases will never combine and produce light and heat, but the moment a light is introduced, the gases in the mixture combine with explosive violence, because the flame made them *nascent*. Still we do not know what the word means. Well let us have another try, and this time we will take a piece of cinder, coke, charcoal or carbon, and we will find that this piece of carbon or cinder may be exposed to an atmosphere containing oxygen, as the air does, for a thousand years, and yet it will not change or oxidize. The writer was present when some excavations were being done to unearth an old Roman military station at South Shields, England, and at the intersection of the *Via Principia* or Main street, with the *Via Transepta* or Cross street of the station, the excavators unearthed the office of the Commandant and here were the remains of his last *coal fire*, and the coals were as bright as if they had been newly taken from the mine, and the cinders were as perfect as if the fire had just died out. The carbon had lain on that hearth for 2,000 years without undergoing any change. Now if by some means a few pounds of the Roman cinder were put on a burning fire and there raised to a *red heat* they would burn or oxidize, until after the lapse of two or three hours nothing would be left but a small quantity of incombustible ash, for in this case the heat would make the carbon *nascent*. Still we do not know what this word means. Then let us have another try to unearth the right definition. Well, all the chemical elements are positive and negative to each other, and a positive will not combine with a positive, nor will a negative combine with a negative, but in all cases the moment two or more elements that are in a high degree positive and negative to each other, are brought together, they combine so greedily, that they devour each other, and produce a body unlike its originators, and it so happens that some bodies, such as carbon, are negative below a *red heat* and cannot therefore combine with oxygen that is also negative, but red hot carbon is positive, and at a white heat it is very positive and therefore *nascent* and consequently intensely quick in combining with oxygen.

89. Chemical Changes of Carbon.—Now, then, we see that carbon is in a nascent condition when heat has changed it from the negative state in which it cannot combine with oxygen, to the positive state in which it combines savagely with that gas. This explanation is of great value to the miner because by it he learns why the flame of his lamp has to be insulated with wire gauze, for otherwise the flame would make the firedamp chemically active or *nascent*, and it is for this reason that coal dust becomes *explosive* in air, where flame makes the hydrogen and carbon of the coal chemically active, or *nascent*, and it is for this reason that *red-hot* coals or cinders are so dangerous in underground fires, because they are so *nascent* that even air containing only a trace of oxygen is sufficient to feed the greedy monster.

Now that we understand the tactics of the enemy, we may assail him with success.

90. Extinguishing Underground Fires.—Then let us resume the subject of the subjection of underground fires with the help of Fig. 129. Here a fire has occurred at *F*,

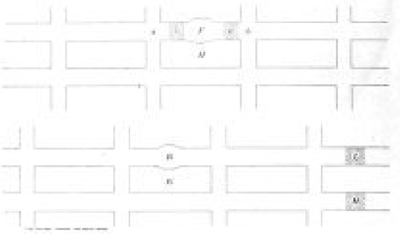


Fig. 129.

and it has been decided to cut it off at its very seat by a stopping at *a* and another at *b*, and let us watch and see what will occur.

First.—The heat will cause such a great expansion of the small volume of confined air, in such a restricted space, that by its great pressure it will force its way through the stoppings, and joints in the roof, floor and sides.

Second.—The heat will convert any water in the roof rock, floor rock, or the coal sides, into steam at a very high pressure, and aided by the expansion of the hot rock, the roof, floor and coal sides will be split and broken, and thus a great number of vents will be made for the breathing of the fire.

Third.—The fire will at once spread into the very heart of the pillar *H*, because the coal will be cracked by the heat, and at the same time its temperature will be raised to the nascent point, and unless checked by a better mode of treatment the whole mine will soon be on fire.

Had the stoppings been built in at the points *L* and *M*, the following results would have followed:—

First.—For a few days the fire would burn fiercely and crack the roof and the coal.

Second.—The temperature of the enclosed air would never rise very high, nor would the pressure of the confined air ever be much above the normal pressure of the atmosphere, because the combined areas of the rooms and headings would prevent compression, and the great extent of the combined surfaces of the roofs, floors and walls would present an enormous surface for the absorption of the heat.

Third.—After the oxygen, in the large volume of air, that made the fire burn fiercely at first, was all consumed, the breathing of the fire would be very slow, because the pressure would be too low, and the volume of the enclosed air too great for rapid exhaustion; again, the heat of the fire could not extend to the rock and coal in which the stoppings were built, hence the vents for exhalation would be of a very constricted character. It is then manifest from the examples before us, and they are the outcome of the writer's experience, that it is a dangerous experiment to constrict the region of an underground fire.

91. An Underground Fire in the Workings.—If a fire occurred in a room as at *F*, Fig. 130, we now know that it would be altogether a serious mistake to stop it off

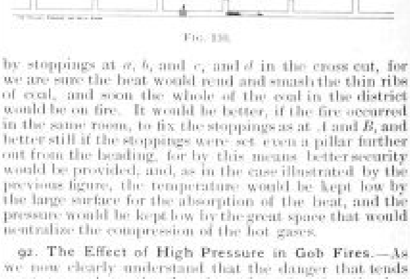


Fig. 130.

by stoppings at *a*, *b*, and *c*, and *d* in the cross cut, for we are sure the heat would rend and smash the thin ribs of coal, and soon the whole of the coal in the district would be on fire. It would be better, if the fire occurred in the same room, to fix the stoppings as at *A* and *B*, and better still if the stoppings were set even a pillar further out from the heading, for by this means better security would be provided, and, as in the case illustrated by the previous figure, the temperature would be kept low by the large surface for the absorption of the heat, and the pressure would be kept low by the great space that would neutralize the compression of the hot gases.

92. The Effect of High Pressure in Gob Fires.—As we now clearly understand that the danger that tends most to prolong the duration of a mine fire, is that variation in the pressure of the confined air, in which it rises sometimes and falls at other times below the pressure of the atmosphere, we should be careful to take steps when this occurs to prevent it, or otherwise nitrogen will be expelled at the period of compression, and oxygen inhaled at the period of depression, and the fire will thus be kept permanently active.

There is one condition of the confined air that will prevent breathing, and that is, to sustain in the region of the fire a pressure above that of the external air. There are many cases in which this would be very difficult to carry out, but where it can be done, it secures the best results. By the sections of a mine, we could determine the height to which water should be raised in the shafts or slopes to sustain a pressure that would be above that of the atmosphere, and if such a pressure could be maintained for a sufficient period the gob could not inhale, and the result would be that the necessary oxygen for combustion would cease, and the hot coal would cool and thereby loose the heat that promotes

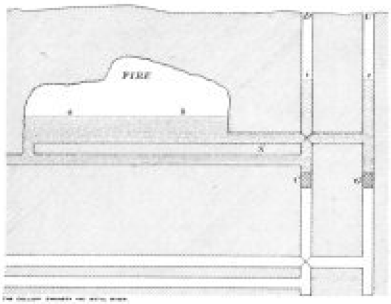


FIG. 131.

chemical activity. Such a case is illustrated by Fig. 131. Here dams have been fixed in the slopes as at *C* and *G*, and the water in the slopes has been raised to the elevations *i* and *e*, while the air is compressed in the region of the fire to the extent of the difference of the water level elevations *a b* and *i e*. But how can we tell that the air is compressed in this case. There is only one way of making the compression in a case like this sure and reliable, and that is to maintain the water levels in the slopes at an elevation above that of the highest point in the gob, and then should any leakage occur, or should the water used for flooding find a downward vent into the lower workings, we could rest assured that the pressure could not be removed from the fire, otherwise should the flooding water find a way of escape, it might cause a depression at the seat of the fire and at the same time produce an inflow of fresh air that would rekindle the fire. Safety then can only be secured by maintaining the water levels in the shafts or slopes at the required

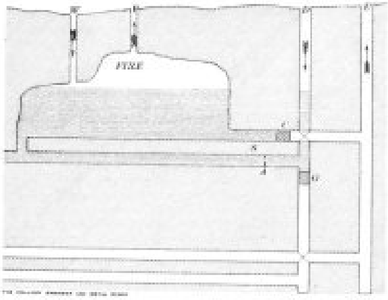


FIG. 132.

height. It is no easy matter to extinguish a mine fire; the whole problem is beset with difficulties that require the utmost care and calculation to secure the successful arrest of the enemy.

Fig. 132 furnishes another mode of treating a mine fire. Here large bore holes, *W*, *W*, have been put down to the crown of the fire region, and a dam has been built in the airway at *C* and in the downcast slope at *G*. The object of this plan is to drown the fire, and no doubt in some cases this is the best mode of proceeding that could be adopted, especially where a copious flood of water can be obtained, and where this water can be quickly and cheaply lifted again. The inflow of the water is indicated by the downward pointing arrow, and the course of the outflowing air is indicated by the upward arrow. There are many cases, however, where this method of drowning the fire could not be applied, and it is for this reason that we must still continue our lessons on the subject.

(*To be Continued.*)

GEOLOGY OF COAL.

The Life Indices of the Coal Period—Geology a Registering Thermometer—The Pentagonal Characteristic of Animal Life.

55. **The Life Indices of the Coal Period.**—There can be no doubt that life is real, and with the successful man life is earnest, but a life without recreative pleasure is like a garden without a rose, and as the miner requires a befitment of technical knowledge much more comprehensive than that of men in many other professions, he should have something to do that would ease the tension of hard study, and at the same time be playfully in line with his daily pursuits. Now we are happy to say that no other professional man is more favorably situated in this respect than he, for geology provides him a magnificent play garden in which he may gather stone lilies for his cabinet, just as a child gathers flowers for a wreath, or he may dig shells out of the rocks, as a child picks them out of the shingle on the ocean's shore. The man's pleasure, however, may outstrip that of the child, because he has scope for his imagination to revive, in mental pictures, a past so mighty that the man who looks into it feels divine. For gauging heat we have registering thermometers that leave at the ends of the thermal range for any period, little index rods, and by looking at the instrument you can by this means tell what has been the highest temperature of the day, or the lowest temperature of the night. Or, if you set aside the instrument for twelve months, at the end of that time the indices show the highest and lowest temperatures of the whole period, and from this we may see that if registering thermometers when placed at a great number of points on both hemispheres of the earth and allowed to remain for a cycle of, say 10 years, we could by this means determine the mean temperature, approximately, for the whole surface of the earth. Now in nature we find indices of heat far more exact than the readings of the best thermometers that man can make; for example, ice melts at an invariable temperature, and never alters, and indeed the scales we use are simply divisions of natural ranges. In the Fahrenheit thermometer the range between the freezing and boiling points is divided into 180 equal parts called degrees, and in the Centigrade thermometer the same range is divided into 100 equal parts that are also called degrees, but the big degree, that is the range between freezing and boiling, is the same in all thermometers. As the laws of nature are constant then, the past would be no exception to the present, and we may be sure, therefore, that lead would melt at the same temperature in Carboniferous times as it does now, and if all this is granted, we may with perfect faith take the figures that are the subjects of this lesson, as *real* indices of the temperatures of the seas in which these creatures lived.

56. **Geology a Registering Thermometer.**—Now this is certainly making geology a registering thermometer, which it is, and the fossils furnish the means of determining with exactness the temperatures of the air or water in which the plants or animals lived. For example, the

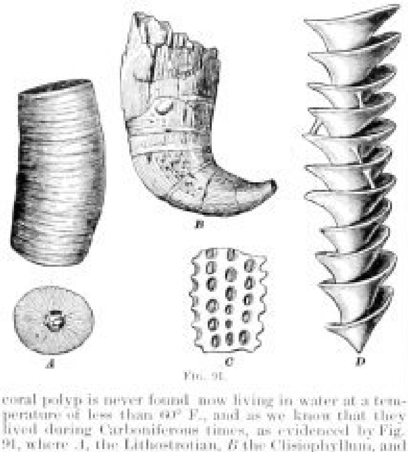


FIG. 91.

coral polyp is never found now living in water at a temperature of less than 60° F., and as we know that they lived during Carboniferous times, as evidenced by Fig. 91, where *A*, the Lithostrotian, *B* the Clisiophyllum, and *C* and *D*, different examples of the Archimedes, were all varieties of coral polyps that lived in the Carboniferous seas. What then is true now is equally true of the Carboniferous period, because we know that the laws of inorganic and organic chemistry cannot change. How, then, can it be said that geology is a profitless study, when it can be made at once a source of pleasure and useful knowledge.

57. **The Pentagonal Characteristic of Animal Life.**—On the floors of the warm seas of the Carboniferous period there grew a lowly budding variety of crinoids

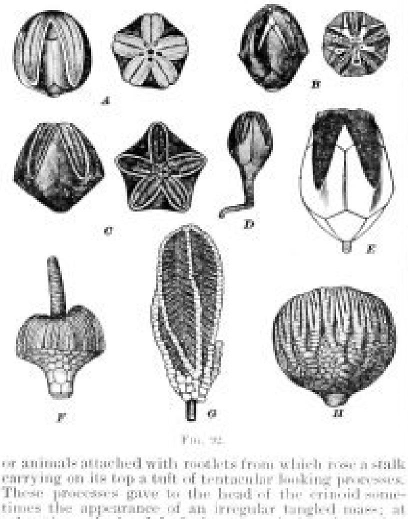


FIG. 92.

or animals attached with rootlets from which rose a stalk carrying on its top a tuft of tentacular looking processes. These processes gave to the head of the crinoid sometimes the appearance of an irregular tangled mass; at other times the head looked symmetrical, and at other times it was so beautiful in the order and repetition of its coronal parts that when it is seen now by a geologist, it is to him an object of wonder and admiration.

The crinoid is somewhat allied to the corals, hence their structure was calcareous, and so varied has been their development that each succeeding geological age has produced its characteristic crinoids, and this was especially so during the Carboniferous period, for its deep, warm seas were especially favorable to the growth of these strange forms of animal life; and so true is this, that this period was distinguished above all the preceding ones for its beautiful crinoids called asteroids. (See Fig 92.) These star-like crinoids are shown at *A*, *B*, *C*, *D* and *E*, and we cannot pass them by without showing

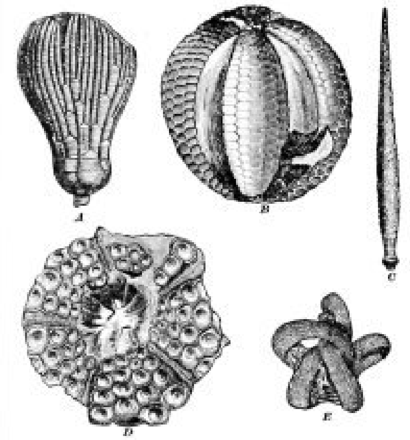


FIG. 93.

how, in a particular manner, they were related to all the higher life forms, for these stone flowers of the sea had their pentagonal plumes and petals, that is, their radiation was in the order of fives, and in this respect they are somewhat related to the radiata, because the star fishes have their five rays, and therefore the pentagonal order of the asteroids of these ancient seas was not singular. The head is so beautiful that in looking at it you can fancy you see the corolla and the calyx of a flower, and it does appear that there is some directive principle in nature that has associated the radial arms of the asteroid with the digits of man, and the rays of a star fish, for the order of five is so common throughout the whole series of simple and complex organisms that the correlation seems complete.

We see, then, that the crinoids are to the miner geologist a matter of engrossing interest. Fig. 93 furnishes more examples of these beautiful pentagons. At first sight *A* appears not to be an asteroid, yet by closely looking at the bottom of the tuft, three of the five bunches of tentacles can be distinctly seen. In the cases of *B* and *D* the asteroidal structure is clear enough. At *C* is shown one of the five tentacles of *E*, where the creature is seen folding its arms as a cuttle fish does its true tentacles.

(*To be Continued.*)

MINING MACHINERY.

Mine Drainage—Correction of the Pump Balance—Is There Such a Principle as Suction?—The Hydrostatic Balance of Pumps—Diagrams of Water and Mercury Balance.

104. **Mine Drainage.**—This is a subject of so much importance to the mining engineer that he is by force of circumstances obliged to understand, among other kindred appliances, the principles of action and the mode of construction of the common pump, and therefore we are going to make it one of the subjects of our Easy Lessons.

The first principle to be understood in the action of the pump is that by which water is made to rise in the upright tail pipe with the appearance of doing so defiantly of the laws of gravitation. For the water to thus rise, however, two conditions are necessary, and the first is, there must be an equivalent reduction of pressure above the water column in the pipe; and the second is, that the pressure of the atmosphere shall so lift the water that the weight of water in the column lifted, added to the reduced pressure above the water, shall be equal to the pressure of the atmosphere. The case has been no doubt correctly stated, but still some obscurity may enshroud the reader's understanding, and we must therefore continue the explanation until the mist that conceals the truth of the matter has been cleared away.

To the definition of the balance given let us add an illustration, and suppose that the piston of the pump has moved upward to an elevation of 20 feet, and further let us suppose that the transverse area of the pipe is equal to one square foot, then if the piston has moved upward from the level of the intake water, or from the surface level of the water lifted, 20 feet, it is clear that if one cubic foot of water weighs 62·5 pounds, 20 cubic feet must weigh 20 × 62·5 = 1,250 pounds, then the weight that will hang on the piston will be 1,250 pounds. Now, if the pressure of the atmosphere has lifted this weight, it is clear that for it so to act, 1,250 pounds pressure per square foot has been removed from the top of the column of water under the piston, and therefore the remaining pressure under the piston must be 2,118 − 1,250 = 868 pounds per square foot, and this is exactly what is the case, for the pressure of the atmosphere in pounds per square foot is 2,118. Now, to prove this, let us suppose that in a vertical pipe 40 feet high and closed at the top perfectly air-tight, while the open end of the pipe dips into water, the liquid will rise into the vacant or vacuum space to an elevation of $\frac{2,118}{62.5} = 33.888$ feet, and we discover by this that 33·888 feet of water column exactly balances the pressure of the atmosphere, and this being so, if 33.888 cubic ft. are equal to the pressure of the atmosphere, or 2,118 pounds per square foot, it follows by a simple proportion that a water column of 20 feet will be the proportion of the whole atmospheric pressure that is represented by 1,250 pounds per square foot, as

33·888 : 20 :: 2,118 : 1,250 exactly.

Or if 33·888 feet of water column balances the pressure of the atmosphere, by a simple proportion we can find what height will balance 1,250 pounds, for

2,118 : 1,250 :: 33·888 : 20 feet.

Now we stated in the beginning that if the weight lifted was added to the pressure beneath the pump piston the sum would be equal to the pressure of the atmosphere, and for a 20 feet lift the weight or strain on the pump rod is equal to $20 \times 62.5 = 1,250$ pounds, therefore $2,118 - 1,250 = 868$ pounds, or to present the case in an easy way,

Pressure of the Atmosphere.		Pressure Under the Piston.		Weight Hanging on Piston Rod.
2,118	=	868	+	1,250.

From this example we clearly discover that the whole matter resolves itself into a question of a balance.

105. Correction of the Pump Balance.—Sometimes clear presentations of a case engender mistaken conceptions of the qualifying merits of the case. Then let it be understood that the equation given is purely *theoretical* and is *not true* in practice for the following three reasons:—

First.—The pressure of the inflowing water has to lift the suction valve and keep it up, and gurgle through the constrictions due to the port way of the valve.

Second.—Water moving through pipes is subject to resistance arising from the wave motion of the fluid, which is known as the friction of the moving fluid.

Third.—The *vena contracta* introduces a resistance at the intake or port of entry.

Further on these causes of resistance will be duly allowed for, but in the mean time let us not lose sight of the fact that so far as suction is concerned the pressure of the atmosphere remains constant, and it may happen, as it sometimes does, where the valve way is constricted or the tail or intake pipe is too small in diameter in relation to the diameter of the piston, that with a 20 feet lift the theoretical pressure beneath the piston is lost by the abnormal resistances being equal to it, and when this is the case we have the following singular equation:—

Pressure of the Atmosphere.		Weight Hanging on Piston.		The Sum of the Resistances.		The Pressure Under the Piston.
2,118	=	1,250	+	868	+	0.

106. Is There Such a Principle as Suction?—There is such a principle as suction in the action of pumps and other kindred appliances, and the word is expressive of what takes place when a fluid *falls* from a higher to a lower pressure, and if the use of such a word was disallowed, then we would be compelled to use modes of expression that would not be half so explicit. Some say the inhalation of a pump takes place by pressure, but this is not correct, because the piston must first act and set up a depression, or reduced pressure, and the word suction refers to the action of the something that makes the depression; if, therefore, we discontinue the use of the word suction, we must invent another word that means suction.

We grant that many persons use the word suction in a mythical sense, and think all the while that it is some peculiar vital action that is outside of the principles of mechanics, but this view of the matter is quite a mistake, for the sucking of the young of mammals is the result of the action of a pump that produces a depression in the mouth. Watch the movement of the lower jaw of the offspring sucking, or experiment on yourself, and you will find that you cannot suck while the teeth in your upper and lower jaws are touching. The milk, then, in the act of sucking, falls from the pressure of the atmosphere into a depression. We will therefore continue to use this correct and most expressive word in this and the future lessons.

107. The Hydrostatic Balance of Pumps.—With the help of the explanation already given we can now take in hand Fig. 140, and we hope the reader will enjoy the

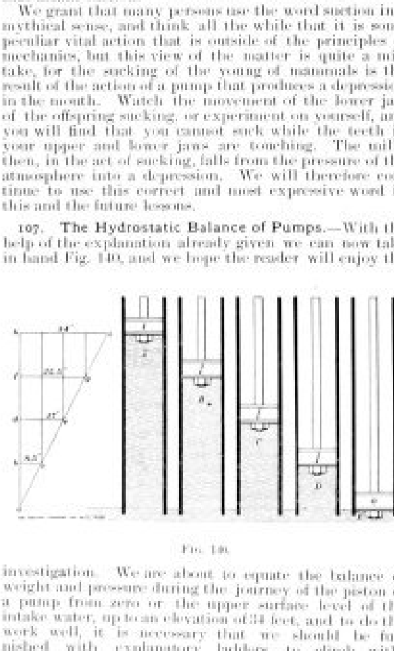


Fig. 140.

investigation. We are about to equate the balance of weight and pressure during the journey of the piston of a pump from zero or the upper surface level of the intake water, up to an elevation of 34 feet, and to do the work well, it is necessary that we should be furnished with explanatory ladders to climb with. All the way up the long stroke we will find *theoretically*, that the atmospheric pressure is equal to the pressure under the piston, plus the weight of the column of water lifted. At the left hand side of the figure a triangular diagram is shown, and the object of this is to show that the amount of mechanical work done at each step is equal to the area of the triangular space below the line of elevation; and starting from the zero height or no elevation at all, we will find that during the first one-fourth or 8.5 feet of the stroke, very little work is done, for it is only equal to the area of the triangle *a b c*, but during the second quarter of the stroke three times as much work is done as in the first quarter, and, therefore, if the work done in the first quarter is proportionate to the triangle *a b c*, the work done in the second quarter of the stroke is proportionate to the area of the trapezoid *b d e c*, and so on with the rest.

Now, let us begin the upward journey of the piston from zero, or 0 to *D*, and here we observe that the under side of the piston has risen one-fourth of the stroke or 8.5 feet, and as a column of water one square foot in the base and 8.5 feet high weighs $62.5 \times 8.5 = 531.25$ pounds, we find the theoretical balance is

Pressure of the Atmosphere.		Weight of Water Hanging.		Pressure Under the Piston.
2,118	=	531.25	+	1,586.75

The work done will be equal to the weight of water lifted multiplied by the height of its center of gravity, and as the center of gravity of the column of water will occur at half the height, we have $531.25 \times \frac{8.5}{2} =$ 2,257.8125 foot-pounds, or the work done in the first quarter of the journey, is equal to $\frac{1}{16}$th of that done during the full stroke.

Next, let the piston rise to *C*, or to half the height of the stroke. We now obtain an instructive equation, because the weight of water hanging will be exactly equal to the pressure under the piston, for if we take the pressure of the atmosphere at 2,125 pounds, to balance, under a vacuum, a vertical column of water 34 feet high, then

Pressure of the Atmosphere.		Weight of Water Hanging.		Pressure Under the Piston.
2,125	=	1,062.5	+	1,062.5

And the work done for one-half stroke will be equal to $1,062.5 \times \frac{17}{2} = 9,031.25$ foot-pounds.

Now, let the piston ascend to the elevation at *B* and the theoretical balance will be, when a column of water one square foot in the base and 25.5 feet high, weighs $62.5 \times 25.5 = 1,593.75$ pounds.

Pressure of the Atmosphere.		Weight of Water Hanging.		Pressure Under the Piston.
2125	=	1593.75	+	531.25,

and the work done for three-fourths of the stroke will be $1593.75 \times \frac{25.5}{2} = 20320.3125$.

Now, to complete the stroke, let the piston rise to *A*, and here the weight of a column of water one square foot in the base and 34 feet high will weigh $62.5 \times 34 =$ 2125 pounds, and therefore the theoretical balance will be:

Pressure of the Atmosphere.		Weight of Water Hanging.		Pressure Under the Piston.
2125	=	2125	+	0

The work done throughout the stroke will be $2125 \times \frac{34}{2} = 36125$ foot pounds.

From the standpoint of the calculated results, the diagram of work cannot fail to be interesting, as by it we can see in a graphic manner the reason why the work done in the different quarters is so divergent that in the first quarter it is only $\frac{1}{16}$, and in the first half of the stroke $\frac{4}{16}$; making the second quarter $\frac{3}{16}$, the first three quarters are equal to $\frac{9}{16}$, thus making the work done during the third quarter $\frac{5}{16}$ of the whole, and the entire work being $\frac{16}{16}$, we find the work done during the last quarter stroke was $\frac{7}{16}$ of the whole.

108. Diagrams of Water and Mercury Balance.—Notwithstanding the fact that a column of 30 inches of mercury balances a column of 406.656 inches, or 33.888

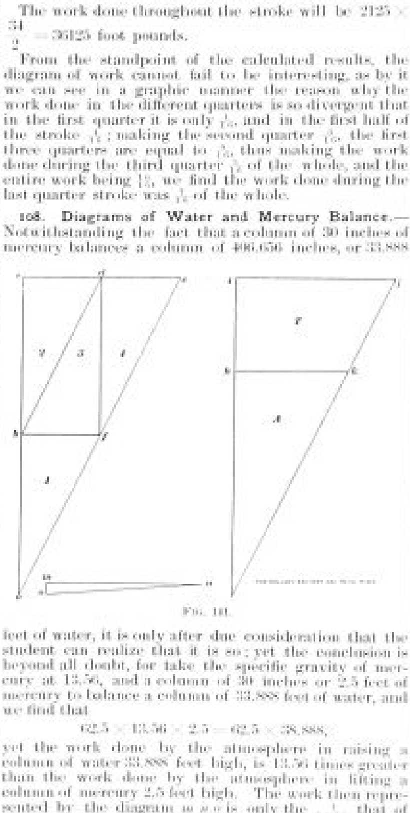


Fig. 141.

feet of water, it is only after due consideration that the student can realize that it is so; yet the conclusion is beyond all doubt, for take the specific gravity of mercury at 13.56, and a column of 30 inches or 2.5 feet of mercury to balance a column of 33.888 feet of water, and we find that

$$62.5 \times 13.56 \times 2.5 = 62.5 \times 33.888,$$

yet the work done by the atmosphere in raising a column of water 33.888 feet high, is 13.56 times greater than the work done by the atmosphere in lifting a column of mercury 2.5 feet high. The work then represented by the diagram *m n o* is only the $\frac{1}{13.56}$ that of the work done in raising the water.

The work done, however, in raising water into a depression, varies directly as the squares of the heights of the column in its ascension, and this is clearly shown by the diagram, where for half the height *o b* the work done is 1, or it is equal to the area of the triangle *o b f*, and the work done for the entire height is 4 times that done at half the height, as shown by the four triangles 1, 2, 3, 4. Again, the square root of $.50 = .707$, is equal to the height *o h*, if the whole height be taken at 1, and the area of the triangle *o h k*, is equal to the area of the trapezoid *h i j k*; therefore, at an elevation of .707 or $33.888 \times .707 = 24$ feet, one-half of the work, has been done in raising the column of water.

109. The Velocity of Water Entering a Pump.—As was shown at first, the velocity of the water entering a pump was such that the result in practice was very

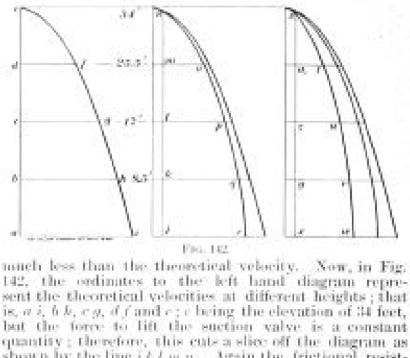


Fig. 142.

much less than the theoretical velocity. Now, in Fig. 142, the ordinates to the left hand diagram represent the theoretical velocities at different heights; that is, *a i*, *b h*, *c g*, *d f* and *e*; *e* being the elevation of 34 feet, but the force to lift the suction valve is a constant quantity; therefore, this cuts a slice off the diagram as shown by the line *i k l m n*. Again the frictional resistance still further reduces the velocities, and therefore we pare another margin off the diagram and the ordinates of the relative velocities are now reduced from *a i* to *j z* and from *b h* to *k q*, and so on. Again the *vena contracta* still further reduces the velocities from *j z* to *z w*, and from *k q* to *q v* and so on.

These three diagrams then show clearly the relationship of the theoretical and practical results.

(*To be continued.*)

Large Electric Locomotives.

The Westinghouse Electric and Manufacturing Company has received the first electric locomotive manufactured under the arrangement entered into some time ago between the Westinghouse Company and the Baldwin Locomotive Works of Philadelphia. In appearance the locomotive is much different from the steam locomotive, and it also shows radical departures in construction from every electric locomotive hitherto manufactured. It is 38 feet long and 9 feet across. All the operating parts of the locomotive have been placed on the truck and the body of the car will only contain the controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by any train. It may also be used as a freight or baggage car.

One of the characteristic features of the locomotive is the truck, which has eight wheels, and is constructed in a very substantial manner. The wheels are 42 inches in diameter. There will be four motors of 200 h. p. each connected to the axles of the locomotive. Thus the entire weight of the locomotive will be placed upon the truck, thereby becoming available for adhesion. This feature of construction will be readily recognized as a very advantageous one over other locomotives, where only a small percentage of the weight is available for adhesion.

The locomotive completely equipped will weigh 160,000 pounds. The motors are geared, which method has been decided upon so as to enable the company to use more efficient and durable motors, and also greatly reduce the cost or the locomotive. It is stated that while the electric locomotive used in the Baltimore tunnel cost $50,000, the Baldwin-Westinghouse locomotive will cost less than one-third of that amount, and yet it will be able to accomplish the same work. The Baldwin-Westinghouse combination is constructing engines for all kinds of purposes. The one described here is the regular passenger engine, rated at 1,000 h. p. capacity. Then there will be locomotives made to be used in mines. The latter will have six driving wheels and the superstructure will consist of a sheet iron cab. The switching locomotives will also have a cab as a superstructure. There will also be manufactured locomotives for tunnel work, suburban traffic and rack locomotives, as well as for elevated railroads.

It is expected that within a few days the second locomotive, as completed by the Baldwin people, will be received at the East Pittsburgh factory of the Westinghouse Electric and Manufacturing Company. This last one will be of the elevated railroad type, and is an example of a motor car of the Manhattan Elevated Railroad of New York.

As far as the speed of these new locomotives is concerned, it may be stated that the motors have been geared to produce a speed of 75 miles an hour, although it may reach 125 miles an hour, if it were demanded. All Westinghouse-Baldwin locomotives will be equipped with air-brakes, which will be operated in the usual manner by an air pump, which is underneath the car, and which will be driven by an electric motor.

The Westinghouse-Baldwin locomotives have been designed so as to be utilized with any method of electric traction. They can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system and they can also be utilized in connection with the Tesla polyphase system.

Since it has become known that the Baldwin-Westinghouse companies are constructing electric locomotives, inquiries have come from all over the world for such machines, indicating the wonderful demand there is for such engines when they are manufactured by such well known firms as the Baldwin Locomotive Works and the Westinghouse Electric Manufacturing Company.

MISCELLANEOUS.

THE GREAT EMERGENCY MAN.

The Vice-Presidency is essentially an office of dignity. No other office under the government has such lofty possibilities for its occupant, while at the same time being so utterly bereft of influence either to wield patronage or to affect legislation.

The Vice-Presidency requires a man fitted to fill the highest office under the government, one whose broad information will make him equal to coping with any national question that might come before Congress, and whose information and position among men would qualify him to preside over the conservative branch of Congress. He is an emergency man. Should death remove the President, it is he who is called upon to occupy the White House. Should there be a tie in the vote of the senate, he, then, has the deciding vote, but, except in this emergency, he is without influence to affect legislation. While the Speaker of the house of representatives assigns all the representatives to places on committees, and in that way virtually determines what legislation shall be enacted, the Vice-President, not being a member of the senate, has nothing to do with the formation of committees, and is not even admitted to the caucuses of his party, in which, if that party have a majority, committee assignments are determined and the policy of the party is mapped out.

The patronage of the Vice-President consists in the appointment of a secretary, a messenger, a telegraph operator, and a telegrapher's page. That is all. The presiding officer of the senate occupies a handsome room, opening on the senate lobby, and he is accorded all the respect which goes with his high office, the chief function of which is to preside over the deliberations of the United States senate.

Because of the peculiar character of the duties of the Vice-President, the daily routine of his life is very different from that of a United States senator. His social life in Washington is just what he chooses to make it. His invitations would not be disregarded by any one in official or social life here, but whether he entertain much or little is a matter purely within his own pleasure. While certain social functions are a part of the official duties of the President, the Vice-President is free to entertain or not, as he sees fit.

But the Vice-President is sought by many visitors to the capital. He is one of the sights of the capital, and visitors from Illinois especially do not like to leave Washington without having sought an introduction to the Vice-President and the man who is regarded as a presidential possibility. But the chances of the Vice-President for the nomination at the hands of the next national convention are rendered smaller because of the fact that since his election his hands have been tied and he has had no opportunity to show the qualities of a leader of his fellow Democrats. Of course, this fact renders the Vice-President free from all responsibility for the acts of his party, although it is probable that in the minds of the masses of the people he is regarded as equally responsible with all Democratic senators for the acts of the last congress.

The duties of the Vice-President do not require him to burn any midnight oil in the consideration of public questions. He has ample opportunity to keep himself informed on all matters that come before Congress by being a good listener, and he has no occasion to prepare any speech for delivery in the senate. He is relieved from all committee work, of course, and even the task of presiding over the senate is rendered an easy one because of the fact that that body is a very docile one to govern, and is not fraught with the perplexing parliamentary problems that are constantly occurring in the house of representatives. The fact that the senate is so largely run by "courtesy" makes it an easy body to preside over.

Perhaps no man connected with the United States senate is so apt to be bored as is the Vice-President. Without power to influence legislation, his office being such that even any suggestion from him would be apt to be regarded as an unwarranted interference, he is yet obliged to attend the sessions of the senate daily, and to recognize this or that one who happens to have a bill to present or a suggestion to make.

From 12 until 2 o'clock is known in the senate as "the morning hour," and during that time all the business of introducing bills, making reports from committees, presenting petitions and memorials, &c., is done. The vice-president is seldom absent from the chair during the "morning hour," but when that expires the "regular business" is taken up, which practically means a continuation of speaking on the pending bill. Then the Vice-President has an opportunity to leave the senate, which he does if there is not in prospect some very interesting debate which he wishes to hear. He seeks his private office, where he frequently holds a reception, for his friends know the hour when he is at leisure and can see them. He generally is on hand when the senate adjourns, and then he has nothing in the nature of official duties to occupy his attention until the day on which the senate is next to meet.—*Washington Evening Star.*

SNOW SHEDS OF THE CENTRAL PACIFIC RAILROAD.

The line of the Southern Pacific Company lying between Blue Canon and Truckee, a distance of 41 miles, is thickly studded with an extensive system of snow sheds costing nearly, if not quite, one and one-half million dollars. During the winter months these sheds are protected from fire by the snow, but in the summer they become very dry and are readily ignited. A spark from a passing engine, or a forest fire, or a match lit by a malicious tramp, may do great damage, not only costing thousands of dollars for repairs, but blocking the road with debris, so that all trains are stopped for several days at a time. Several years ago the railroad company reduced the danger of fires being set by tramps by issuing orders to trainmen to let those gentry of the road ride through the sheds whenever they boarded a freight train, and under no consideration to put them off until the sheds were passed, but other dangers threaten which do not offer so easy a remedy. In spite of spark arresters on the locomotives sparks will rise. Nor does there seem to be a way to keep the camper from breaking camp and leaving his fire burning behind him.

All of these dangers have been reduced to a minimum. The necessities of the occasion demanded a remedy, and this has been found in a system of fire alarms, patrols and fire trains that probably surpasses anything of the kind in the world. Situated at a distance of a mile apart throughout the entire length of shed-guarded track are placed unlocked electrical call boxes similar to those in use in the cities. On the face of these are inscribed the words: "East—west—rock on track—shed down—train wreck—car off slide—fire." Besides these there are 34 fire alarm boxes, which are kept locked. These are used exclusively for fire. When an alarm is rung in on one of these a gong strikes the number of the box in Sacramento, 100 miles away, and at the different points where the fire trains are situated.

The forty miles of shed are constantly patroled by men selected for that purpose. Each man's beat is less than three miles long, and is so arranged that he passes over it a short time in advance of every train. The most important of all, however, are the duties performed by the fire trains, of which there are three. These trains consist of an engine and tender and two flat cars, upon which there are mounted immense boilers filled with water. These boilers are decked to afford room for the crew when at work on a fire. The regular crew consists of three men—the engineer, fireman and brakeman. But when an alarm is rung this is enhanced by picking up the nearest section gang. Of these fire trains one is stationed at Blue Canon, another at Summit, and a third at Truckee.

Whenever a patrolman discovers a fire in a shed he hurries to the nearest box and turns in the alarm. Instantly the number is sounded on a huge gong in Sacramento and at fire stations. The crew of the fire train nearest the point of danger spring to their places and await orders from Sacramento. At the latter place the train dispatcher seizes his key and sends his orders along the road to side-track all trains. A few minutes pass and the word comes flying over the wire that the last train is out of the way. The dispatcher then strikes the key again, and the fire train receives the word "track clear; box 28; go." The engineer seizes the throttle, the fire train moves out on the main track and starts for the scene where it is to do battle.

When the scene of a fire is reached the train is stationed as near as possible to the burning timbers, and the battle begins. The method pursued is the same as is used by the city fire departments. Two streams of water are thrown against the flames, and it is rare that the fire is not under control in less than twenty minutes. If the wind is against them the engineer must be careful not to let his train get too close, and the axe and pickaxe men who toss aside the burning timbers must look alive that the weakened sheds do not fall upon them. It has been a number of years since there has been a fire of any consequence in the sheds. The largest fire that ever occurred was in 1878, when 5,000 feet one mile west of the summit went up in smoke.

During the intervals between fires in the summer the trains are used in wetting down the sheds, so as to reduce as far as possible the chances of their being ignited by sparks from passing engines. For this purpose the fire trains are rigged with spray nozzles, which completely deluge the interior of the sheds as they steam slowly through them.—*San Francisco Chronicle.*

INDIA PAPER.

The marvelous Oxford India paper was first introduced in 1875. Since then it has revolutionized the Bible and prayer book trade, and it is now used for all the more popular devotional books throughout the world. In the year 1841 an Oxford graduate is said to have brought home from the far East a small fold of extremely thin paper, which was manifestly more opaque and tough for its substance than any paper then manufactured in Europe. He presented it to the Clarendon press. The late Thomas Combe, who had only recently been appointed printer to the university, found it to be just sufficient for 24 copies of the smallest Bible then in existence—diamond 24mo—and printed an edition of that number, which bore the date of 1842. The books were barely a third of the usual thickness, and, although as much as $100 apiece were offered for them, no copies were sold, and they were presented to the queen and other distinguished persons.

All efforts to trace the paper to its source were futile, and as years rolled on the circumstance was forgotten. But early in 1874 a copy fell into the hands of Arthur E. Miles, who showed it to Mr. Froude, and experiments were at once set on foot at the Oxford university paper mills with the object of producing a similar paper. The first attempts were failures, but success was achieved, and Aug. 24, 1875, an edition of diamond 12mo Bible, similar in all respects to the 24 copies printed in 1842, was placed on sale. This was the first Oxford Bible published by Mr. Froude. The feat of compression was looked upon as astounding, the demand was enormous, and before long 250,000 copies had been sold. The paper when subjected to severe rubbing, instead of breaking into holes, assumed a texture resembling chamois leather, and a strip only 3 inches wide was found able to support a quarter of a hundredweight without yielding. The secret of its manufacture, it may be said, is known to only three living persons.—*Book Review.*

THE ORDINARY EARTHWORM.

The common earthworm, despised by man and heedlessly trodden under foot, fulfils a part in nature that would seem incredible but for the facts revealed by the patient and long-continued researches of Darwin. "Worms," says Darwin, "have played a more important part in the history of the world than most persons would at first suppose." Let us follow Darwin and see how this apparently insignificant creature has changed the face of nature. We will first consider the habits and mode of life of the earthworm. As every one knows, the worms live in burrows in the superficial layer of the ground. They can live anywhere in a layer of earth, provided it retains moisture, dry air being fatal to them. They can, on the other hand, exist submerged in water for several months. They live chiefly in the superficial mould less than a foot below the surface, but in long continued dry weather and in very cold seasons they may burrow to a depth of eight feet. The burrows are lined by a thin layer of earth, voided by the worms, and end in small chambers in which they can turn round.

The burrows are formed partly by pushing away the earth, but chiefly by the earth being swallowed. Large quantities of earth are swallowed by the worms for the sake of the decomposing vegetable matter contained in it, on which they feed. The earth thus swallowed is voided in spiral heaps, forming the worm castings. In this case the worm obtains food and at the same time excavates its burrows.

In addition to the food thus obtained, half-decayed leaves are dragged into the burrows, mainly for food, but also to plug the mouths of the burrows for the sake of protection. Worms are also fond of meat, especially fat; they will also eat the dead bodies of their relatives. They are nocturnal in habit, remaining, as a rule, in the burrows during the day and coming out to feed at night.

The earthworm has no eyes, but is affected by strong light if exposed to it for some time. It has no sense of hearing, but is sensitive to the vibrations of sound. The whole body is sensitive to touch. There appears to be some sense of smell, but this is limited to certain articles of food, which are discovered by the worm when buried in earth, in preference to other bodies not relished. The worm appears to have some degree of intelligence from the way in which it draws the leaves into its burrows, always judging which is the best end to draw them in by. This is remarkable in so lowly organized an animal, being a degree of intelligence not possessed by many animals of more complex organization. For instance, the ant can often be seen dragging objects along traversely instead of taking them the easiest way.

As we have seen, vast quantities of earth are continually being passed through the bodies of worms and voided on the surface as castings. When it is stated that the number of worms in an acre of ordinary land suitable for them to live in is 53,000, we can imagine the great effect which they must have on the soil.

They are, in fact, continually ploughing the land. At one part of the alimentary canal of the worm is a gizzard, or hard muscular organ, capable of grinding food into fine particles; it is this gizzard which is the main factor in triturating the soil, and it is aided by small stones swallowed with the earth, which act as millstones.

In consequence of the immense amount of earth continually being brought to the surface by worms it is not difficult to understand how objects, such as stones, rocks, &c., lying on the surface, will in course of time become gradually buried in the ground. Owing to the burial of stones and other objects by the action of worms, ancient monuments, portions of Roman villas, and other objects of antiquity have been preserved. These have been gradually buried by the worms, and so preserved from the destructive effect of rain and wind. Many Roman remains were studied by Darwin, and traces of the action of worms found, to which action their preservation was mainly due. The sinking of the foundations of old buildings is due to the action of worms, and no building is safe from this unless the foundations are laid lower than the level at which the worms can work, namely, about eight feet below the surface.

Another useful effect produced by worms is the preparation of the soil for the growth of seedlings. By their agency the soil is periodically sifted and exposed to the air, and in this way is able to retain moisture and absorb soluble substances of use for the nutrition of plants.—*Knowledge.*

FIRING A BIG NAVAL GUN.

There will take place in a very short time a test which will mean much to the United States navy, and which will be watched with interest by armament and naval experts the world over. It will determine whether or not the firing of the 13-inch gun on the first of the United States' three battle ships, the Indiana, will or will not cripple that magnificent floating fortress. It is a matter regarding which few people are informed and which has, therefore, not attracted public attention.

During the forty-eight hour ocean run which she will take, and which will be the government's test of her capabilities, she will discharge the 13-inch guns with which she is equipped, this being the first time in the history of our government that so large a gun has ever been fired from a vessel.

Few people understand the seriousness of this feat. Let us first understand what a 13-inch gun is, and the Indiana, by the way, carries four of them in addition to a large number of weapons of smaller calibre. Each of the 13-inch guns on the Indiana is 39 feet 11½ inches in length—one-half inch less than 40 feet. Each weighs about 67 tons. Each fires a solid steel shot or shell 13 inches in diameter and about 4 feet in length. Each of these weighs 1,300 pounds, and is composed of a quality of steel that costs 23 cents a pound, making the valuation of each shot exactly $299. To fire this projectile, when in war action, requires the use of 500 pounds of powder, so that it will readily be seen that each discharge of the gun costs a pretty penny. With that amount of explosive force back of it the 13-inch gun will throw one of these steel messengers of death to a distance of about twelve miles. Imagine a projectile of that size—we are speaking now of solid shot—striking the side of a vessel, say, only two miles away. It would require a wonderfully perfect condition of armor to withstand the shock of the impact.

But the question of cost and the question of force do not involve the most serious aspect of the trial of the 13-inch gun which will take place in the near future.

Some time ago the English government experimented with a 13-inch gun on a ship of the Royal Sovereign class. At the first firing of the gun the entire upper deck was lifted from its position and sprung along its entire centre, so terrible was the shock. The Indiana has been specially equipped to provide against any such disaster, and her decks have been constructed in such a manner that naval experts agree that no such damage can befall her when the 13-inch guns send out their flaming messages. Naval experts are agreed, however, that when she is in action and the four 13-inch guns are performing their deadly work the explosions will shatter and destroy every piece of woodwork and glass in every portion of the vessel. That is expected and prepared for, and for that reason the battleship Indiana is composed almost entirely of iron and steel. She has been aptly described as an enormous floating steel fort with a ship built around it for purposes of navigation. Fully one-half of her could be shot away and she would still float and retain her unequalled fighting power.

But it is not Uncle Sam's wish that this grand marine monster should have her exterior furnishings wrecked before there is any necessity for it, and therefore the officers who will have charge of the approaching test, instead of placing a charge of 500 pounds of powder behind one of the 1,300-pound projectiles, will use only 300 to 350 pounds, and thus it is hoped that while they will satisfy themselves as to the working of the gun they will not wreck the interior woodwork of the vessel.—*Philadelphia Times.*

THE BRONCHO.

A few words about this horse, the horse of the plains. Whether or no his forefathers looked on when Montezuma fell, they certainly hailed from Spain. And whether it was missionaries or thieves who carried them northward from Mexico, until the Sioux heard of the new animal, certain it also is that this pony ran wild for a century or two, either alone or with various red-skinned owners; and as he gathered the sundry experiences of war and peace, of being stolen, and of being abandoned in the snow at inconvenient distances from home, of being ridden by two women and a baby at once, and of being eaten by a bear, his wide range of contretemps brought him a wit sharper than a street Arab's, and an attitude toward life more blase than in the united capitals of Europe. I have frequently caught him watching me with an eye of such sardonic depreciation that I felt it quite vain to attempt any hiding from him of my incompetence; and as for surprising him, a locomotive cannot do it, for I have tried this. He relishes putting a man in absurd positions, and will wait many days in patience to accomplish this uncharitable thing; and when he cannot bring a man to derision, he contents himself with a steer or a buffalo, helping the man to rope and throw these animals with an ingenuity surpassing any circus, to my thinking. A number of delighted passengers on the Kansas Pacific railway passed by a Mexican vaquero who had been sent out from Kansas City to rope a buffalo as an advertisement for the stock-yards. The train stopped to take a look at the solitary horseman fast to a buffalo in the midst of the plains. Jose, who had his bull safely roped, shouted to ask if they had water on the train. "We'll bring you some," said they. "Oh, I come get," said he; and jumping off, he left his accomplished pony in sole charge of the buffalo. Whenever the huge beast struggled for freedom, the clever pony stiffened his legs and leaned back as in a tug of war, by jumps and dodges so anticipating each move of the enemy that escape was entirely hopeless. The boy got his drink, and his employer sent out a car for the buffalo, which was taken in triumph into Kansas City behind the passenger train. The Mexican narrated the exploit to his employer thus: "Oh, Shirley, when the train start they all give three greata bigga cheers for me, and then they give three mucha bigger cheers for the little gray hoss!"—*From "The Evolution of the Cow-Puncher," by Owen Wister, in Harper's Magazine.*

DOCTORS IN CHINA.

The life of a medical missionary in China is filled with difficulties, any one of which may become a source of positive danger at any time.

In the making of a diagnosis many perils lurk. The fever thermometer, the tongue depressor or the stethoscope may be remembered as an evil implement in the hands of the foreigner, calling down upon the patient a bad spirit, if he should happen to die even at some far distant time, while the use of more complicated instruments in examining the throat, nose or eye is advisable only in selected cases.

In prescribing medicines not only is the fear of a future accusation of poisoning ever present, but the possibility that it may prove to be a reality. Thus a bottle of liniment curing the venerable grandmother of rheumatism may be lent to a neighbor stricken with small pox as an infallible remedy, or the entire contents of a vial of toothache medicine be administered in one dose to a teething infant. And, without exception, the heathen Celestials reason that if a small portion of medicine is of any benefit, the whole bottleful, taken at once, multiplies its usefulness in a corresponding ratio. Therefore, if not previously warned, experience soon teaches the missionary to make it an infallible rule never to dispense a poisonous remedy or one which could do harm if the entire quantity were taken at once.

When it is absolutely necessary to administer a powerful remedy several times or for several days in succession, the doctor puts each dose up in a separate vial, powder or capsule, and, leaving them at the dispensary with a trained American nurse or other foreign helper, directs that a servant or child of the patient be sent there for one every three hours, or three times a day, as the case may require; otherwise it would all be taken at once or divided among ailing neighbors.

The complications and responsibilities usually attendant upon grave operations are, in China, multiplied a thousand-fold. An operation must never be done in private, but in a room where it is possible for the natives to observe the mysterious rites from outside posts of observation. It is possible that they may take alarm at any stage of the proceedings, to be appeased only with great difficulty, and the death of the patient may be followed by an open revolt. On the contrary, if the operation is successful, people afflicted with all sorts of irremedial surgical ailments in nowise resembling the preceding one are brought to the little hospital with the demand that they also be relieved.

Against the administration of an anæsthetic there is the greatest prejudice, the condition of temporary unconsciousness produced by it being beyond Chinese comprehension. In the majority of cases, however, it is easily dispensed with, the stoicism or the insensibility to pain of the average Chinese being remarkable. He or she will open the mouth and submit to having every tooth extracted without a grimace or a groan.

The dread of smallpox and cholera displayed by foreigners fills the Celestial mind with surprise, and any show of absolute fear, with the utmost contempt. "Why be afraid of smallpox," they ask, "when thousands of Chinamen die from it every year? We know there is nothing to fear from it." In these cases the forlorn hope of the Chinese leech is the famous red pills, globules of the bigness of a pin's head, whose composition is secret and whose curative properties are in Chinese eyes unequaled.

During an epidemic of either of these contagious diseases patients so afflicted are daily brought to the hospital, asking for admission, but the reasons for their rejection fall upon uncomprehending and dissatisfied minds. It is utterly impossible to establish any form of quarantine, or to prevent members of the affected families from going wherever they desire, while the physician has great reason to congratulate herself if she succeeds in excluding them from visiting the dispensary and hospital wards.—*Philadelphia Times.*

ENGINEERING BY A MOUSE.

"While digging holes for telegraph poles at Byron, Me.," said a Western Union man, "I became interested in watching the ingenuity and perseverance of a mouse. He fell into one of the holes, which was 4½ feet deep and 20 inches across. The first day he ran around the bottom of the hole, trying to find some means of escape, but could not climb out. The second day he settled down to business. He began steadily and systematically to dig a spiral groove round and round the inner surface of the hole with a uniformly ascending grade. He worked night and day, and as he got further from the bottom he dug little pockets where he could either lie or sit and rest. Interested witnesses threw in food.

"At the end of two weeks the mouse struck a rock. This puzzled him. For nearly a day he tried to get under, around or over the obstruction, but without success. With unflinching patience he reversed his spiral and went on tunneling his way in the opposite direction. At the end of four weeks he reached the top and probably sped away to enjoy his well-earned freedom. His escape was not seen. When his food was put in in the morning, he was near the surface, but at night the work was seen to be complete, and the little engineer, whose pluck and skill had saved his life, had left."—*New York Sun.*

HOW THE GOVERNMENT BORROWS MONEY.

The announcement recently made that for thirty days the Secretary of the Treasury would receive bids for United States bonds means that our government proposes to borrow money. The amount named is one hundred million dollars.

In general, it may be said that a nation, like a railway or other corporation, borrows money by selling its written promises to pay. Indebtedness may be contracted in the ordinary course of affairs when services or commodities obtained by the government are not paid for at once. Such liabilities are called a "floating debt." But the contraction of this sort of indebtedness could hardly be called borrowing.

In the case of voluntary loans, now by far the commonest way in which a nation borrows, the debtor government usually pays interest to its creditors at a fixed rate on the par value of its paper. On some of its obligations, however, which are redeemable on demand, our own government pays no interest at all. Such, for example, are the United States notes, commonly called "greenbacks," which circulate as money, and are legal tender in payment of debts. Not many years ago the greenbacks were not redeemable on demand, and their legal tender quality, therefore, gave them the nature of an involuntary or "forced" loan.

On bonds, such as those now about to be issued, the government promises to pay interest until it redeems them. It also names a certain term of years which must elapse before it will even have the right to redeem them; that is to pay off the principal of the debt now incurred. The rate of interest and the number of years the bonds are to run may usually vary widely; but at present our laws permit only three kinds of bonds to be issued, viz., those running ten years with interest at 5 per cent., those running fifteen years with interest at four and one-half per cent., and those running thirty years with interest at four per cent. This issue is to be of the last-named class.

How to place the bonds on the market is a question which the President and the Secretary of the Treasury are called on to decide. There are several ways. A private contract may be made with a syndicate or group of capitalists, without any public advertisement of the issue. An advantage claimed for this method is that conditions such as the government desires to impose, but which are not described in the bonds themselves, may be prescribed in the contract.

Another plan is to employ a syndicate, or perhaps a single great banking house, as the agent of the government in floating the loan. A fixed commission is paid to the agent, who can employ, in selling the bonds, business machinery which the government may not possess, and so secure better terms. This method is frequently employed when it is desirable to dispose of the loan abroad. It was largely resorted to when we were borrowing the money needed for prosecuting the Civil War.

The government may, however, dispense entirely with the use of agents, and deal directly with the entire mass of purchasers, as in the present case. Offers are received from anybody, and in large or small amounts. This is a "popular" loan. The term may also properly be applied even to a loan contracted through an agency, provided there is an opportunity for all who so desire to invest money in the bonds.—*Youth's Companion.*

DWARFS IN THE PYRENEES.

There has long dwelt in the heart of the Pyrenees, on the old Catalonian border of Spain, a curious race of dwarfs, supposed by some to be of Tartar origin. A writer in a recent issue of *Cosmos* describes them and advances a theory of their origin in consonance with modern anthropology.

They inhabit the valley of the Ribas in the northwestern part of the Spanish province now called Gerona. They never exceed 51¼ inches in height and have short, ill-formed legs, great bellies, small eyes, flat noses, and pale, unwholesome complexions. They are usually stupid, often to the verge of idiocy, and much subject to goitre and scrofulous affections. The chief town of the Ribas Valley is Ribas, a place of 1,500 inhabitants, about 800 feet above sea level. The mountains rise about the town to a height of 6,000 to 8,000 feet, and command an amazingly beautiful panorama of mountain, plain, and river, with Spanish cities visible upon the one side and French upon the other. The region is rich, both agriculturally and minerally, and is famous for its medicinal springs. In this paradise dwell the dwarfs, perhaps as degraded a race of men and women as may be found in any civilized community. They are almost without education, and inhabit wretched huts when they have any shelter. The most intelligent are employed as shepherds, and in summer they live for months at an elevation of more than 6,000 feet without shelter. Here they see no human creature save some of their own kind, often idiots, who are sent up every fifteen or twenty days with a supply of food.

It is said that formal marriage is almost unknown among them. The women in some instances are employed in the village of Ribas as nurses for children, and as such are found tender and faithful. Before communication throughout the region was as easy as it is now it was thought lucky to have one of these dwarfs in a family, and the dwarfs were hired out and even sold to be used in beggary in neighboring cities. There are somewhat similar dwarfs in other valleys of the Pyrenees, but the number is decreasing, and those of the Ribas Valley are reduced to a few individuals.

The writer of the *Cosmos* article rejects the theory of a Chinese origin for the dwarfs, and believes that they are merely the degenerate descendants of the ordinary natives, ill-nourished for generations upon a diet of potatoes and black bread. The fact that with improved means of communication the dwarfs are decreasing helps to confirm the writer's theory, and he believes that with proper nourishment and decent shelter their descendants would gradually return to the normal type. Meanwhile the neighbors of the dwarfs look upon them with a curious mixture of feelings. The fact that the dwarfs drink much at a particular mineral spring has given rise to a superstition that whoever drinks of it will become deformed, and the normal natives are horrified to see visitors experimenting with the dreaded waters. There is reason to believe that the waters of the spring are beneficial to the stomachs of well nourished persons, but injurious to those who are accustomed to an unwholesome diet, and it is entirely possible that the ill-fed dwarfs have been injured by drinking of the spring.—*New York Sun.*

ODD PRODUCTS OF UTAH'S MINES.

Utah, the newest of the states, seems to be a mineralogical freak. Mr. George Eldridge, of the Geological Survey, was sent out there a few weeks ago for the purpose of looking up certain natural resources, and he has returned with a most interesting report. Among other things he found great deposits of mineral rubber—enough to make gum shoes for a large part of the population of the United States. A piece of this substance about eight inches square and one inch thick was lying on his desk. It was black, and looked and felt exactly like ordinary rubber, and was quite elastic. The scientific name for this substance is "elaterite." It may, in the future be put to many valuable uses, and for a roofing material has already proved excellent.

In the mining towns of Utah mineral rubber is utilized commonly for roofing, being prepared in sheets consisting of a layer of burlap, with the rubber on both sides. Nothing could be more thoroughly waterproof.

Another unexplored mineral and one about which very little is known, is mineral wax, or as it is scientifically known "ozokerite." In parts of Utah it is found in veins, like the mineral rubber, though sometimes the ozokerite occurs in pockets between layers of shale. It has not been mined at all but many uses for it are likely to be discovered in the future. To electricians it will be valuable, inasmuch as it is one of the best insulating materials known.

Gum asphalt represents a great mineral resource that has hardly been touched as yet as it has only been mined to a small extent. It is an exceedingly pure kind of asphalt, and its important usefulness is in the manufacture of varnishes. The conditions under which it is found are so extraordinary that nobody has been able to account for them satisfactorily. The deposits are found chiefly within and in the neighborhood of the Uncompahgre reservation. It appears in veins having a tendency to run parallel to each other with a trend from northwest to southeast. These veins vary in width from a quarter of an inch to eighteen feet and they are from half a mile to six miles in length. Nobody knows how deep they are. It is believed that they extend to a depth of at least 1,000 feet, so that the quantity of material obtainable is enormous. The greatest depth thus far reached is 125 feet. Mining for the stuff has hardly got beyond the prospecting stage. The veins are perfectly vertical. For a few feet from the surface the substance is more or less impure, owing to weathering, but lower down it is entirely free from impurities. Digging for it is the hardest work imaginable, owing chiefly to the dust. The atmosphere of the shafts becomes literally loaded with asphalt dust, which is highly explosive. The body heat melts it so that it forms a brown coat all over a person exposed to it. Soap and water are no good for washing it off. The only thing that will remove it is kerosene. A tank of kerosene is kept handy, so that everybody who comes out of the mines may take a bath.—*St. Louis Globe-Democrat.*

EXPERT LONDON DRIVERS.

The majority of the streets of London, at least those on which the principal traffic of the city proper centres, are narrow, and the navigating of the 'buses along these highways, which are always crowded to distraction with every description of vehicle, large and small, is a feat in driving which would turn the hair of a Broad street 'bus driver gray in a day and drive him crazy in a week. But his London prototype does not lose any sleep of nights worrying about it. To him the safe conduct of his 'bus along his route is work of the most ordinary kind.

It is generally acknowledged that these 'bus men, who undergo a course of long years of most careful training, are, when put to it, the finest drivers in the world, but, at the same time, their every-day task is made comparatively easy for them by the punctilious observance of the rules of the road, practiced by every Englishman who drives in London, be he lord or commoner.

There is never the slightest trouble caused by the misunderstanding of these rules by an ignorant driver; the most ordinary costermonger who drives his little donkey cart in the crowded section of the city is perfectly familiar with them, and never evinces the slightest inclination to rebel against their dictates by not pulling up out of the way when a coach or four-in-hand signals its intention to drive by.

The first time an American mounts the steep steps at the back of a 'bus and takes a seat on the roof for a ride along Fleet street or the Strand, or a trip down Cheapside, his attention is riveted for the greatest part of the journey and his breath frequently taken away in watching the manœuvres of the 'bus driver.

The way these men keep their horses under control and steer their clumsy vehicles in and out of the constant crush of wagons and all manner of vehicles is exciting and wonderful. Look ahead of you and the street seems packed, with only a small opening, which to the eye of the uninitiated appears scarcely wide enough for a 'bus to go through, and yet the driver goes ahead unhesitatingly, and, presto, change, in a minute you are through the crush, and have never even scraped the wheels of the wagons on either side of you.

If, however, one of these wagons had suddenly turned into the narrow passageway through which you have passed, the driver bent on getting out before the 'bus, there would have been a crash and a smashup, an accident which very likely would happen under similar circumstances a dozen times in a day in an American city. But between the drivers of the wagons and the 'bus drivers, and all other drivers in London, perfect confidence exists, the 'bus driver, knowing that he has the right of way, going ahead without fear, while the driver of the cart or wagon, being fully aware that he must stand aside so that the lumbering public conveyance can go through, does so without a murmur of discontent at the few minutes of lost time which he is bound to suffer.—*From the Philadelphia Times.*

FATIGUE.

Fatigue is the natural result of labor, and as such is a periodic symptom with which every healthy person is familiar.

It is one of the laws of organic life that periods of relaxation shall succeed periods of activity. The heart itself is normally in repose for about one-third of the time consumed by each beat—a fact in which there is something particularly suggestive and interesting, since physiologists agree that about one-third of the twenty-four hours should be devoted to sleep.

Life is made up of series of vibrations in which tension and rest succeed each other. The heart vibrates about seventy times a minute; the vibrations of the respiratory organs occur about sixteen times in the same period; while the vibrations of the whole organism may be said to complete their cycle once in twenty-four hours.

Abnormal fatigue, a state approaching exhaustion, occurs when one attempts to alter nature's rhythm; when the hours of tension are made to encroach upon those which should be devoted to rest; when muscle and nerve already fatigued are driven to further exertion.

Fatigue of a kind known as overtraining results, in the case of the athlete, in heart-weakness and shortness of breath—"loss of wind," as it is called; while the long-continued fatigue occasioned by excessive application to professional or business pursuits results in nervous prostration, or even in paralysis.

While excessive fatigue is in itself unwise, one of the chief dangers which result from it is that commonly indicated by the term "catching cold." Thus the danger of sitting in a draft or on the damp ground is many times doubled after great exertion. The application of heat to the surface is a more logical procedure after extreme fatigue.

Loss of sleep is one of the first symptoms of abnormal fatigue. Habitual insomnia from this cause is to be treated only in one way, by absolute rest.—*Youth's Companion.*

A MYSTERIOUS CRATER.

About forty miles from Flagstaff, Arizona, in the midst of a great plain, there is a saucer-shaped hollow about three-quarters of a mile across and six hundred feet deep. The rim of this strange crater rises between one hundred and fifty and two hundred feet above the surrounding plain. Rocky fragments are scattered for several miles around the crater, decreasing in number until they disappear. Among these rocks many fragments of meteoric iron, some containing minute black diamonds, have been found. The inner walls show that the crust of the earth was broken when the crater was formed; yet no volcanic rocks exist there. Geologists have recently proposed several theories to account for this singular phenomenon. One theory is that an immense meteorite made the hole, and that the meteoric fragments just mentioned are remnants of the falling star. Another theory ascribes the origin of the crater to a tremendous explosion of steam in the rocks beneath; and a third combines the first two by suggesting that the blow of a falling meteor, striking the earth's crust at a point where subterranean water had accumulated in the neighborhood of heated rocks, was the cause of the explosion.—*Youth's Companion.*

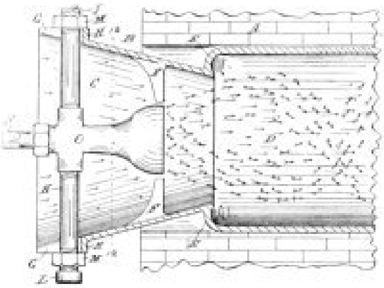
The Telegrapher's Ear.

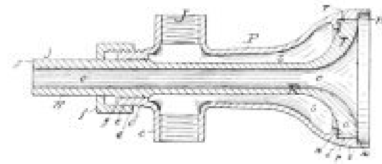
Any operator who is accustomed to work by sound with men every day can tell in an instant just who is working the key. There is something peculiar in the way each operator opens and closes his key. Of course it is entirely a matter of education of the ear. Another evidence of the susceptibility of the aural nerves to education is the fact that an operator can receive and copy a message and at the same time distinctly hear and comprehend everything that is being said by others in the room. He can be very busily engaged at anything, and yet his ear will take in everything that is said near him. Another peculiar thing is the fact that a telegrapher working at night will lay his head within two inches of a working instrument and sleep as soundly as though in bed. He will not be disturbed in the least until his own office call is sounded by the instrument. That will awaken him in an instant. Of course each sound is exactly of the same degree of intensity, and it is only the training of the ear that causes him to distinguish his office call when even asleep.—*Philadelphia Times.*

NEW INVENTIONS.

STEAM BLOWER.

No. 551,927. William A. Eudaly, Cincinnati, Ohio. *Patented Dec. 24th, 1895.*—Fig. 1 is a vertical section of the apparatus; and Fig. 2 is a lengthways section of the steam jet. The steam enters through the pipe *J*, and passes into the space between the shell *P*, and the central tube *R*. This tube has a flange, or head, *T*, at the front end, which is seated, steam tight, upon the shoulder *n* of the shell *P*. The escape





of steam from the chamber *S*, is controlled by screwing the tube *R* forward or back by means of a wrench applied to the shank *j*. The steam jets are made by grooves *r*, which are cut in the rim of the head *T*. These grooves taper in depth as shown, being almost nothing at the front edge. The volume of steam which may be delivered by each jet, may be varied, without changing the pressure, by moving the head *T* forward beyond the shoulder *n*, of the shell, thus increasing the depth of each opening at the point of discharge. Should any dirt lodge in a jet and clog it, it may be blown out by advancing the head *T* still farther forward; this may be done without stopping the blower.

AUTOMATIC COAL BIN.

No. 553,075. Charles S. C. Rock, New York, N. Y. *Patented Jan. 14th, 1896.* Fig. 1 shows the position of the parts before and after the bucket has been filled, and Fig. 2 shows the mode of filling the bucket. This device is designed for the use of tenants in "flats" and tenement houses, where the coal is kept in the cellar or basement. Each floor or tenant

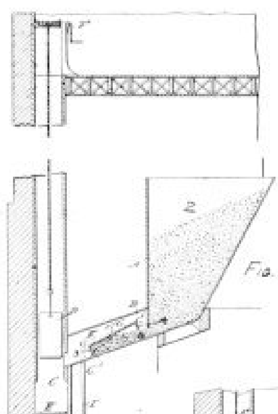


Fig. 1

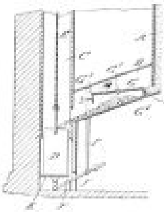
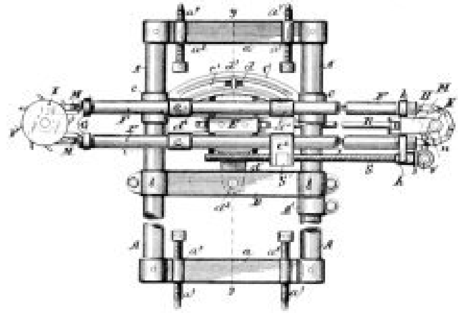


Fig. 2

is provided with a hoisting apparatus and bucket, which takes coal from a certain compartment of a general coal bin 2. Each chute is provided with a rocking frame *G*, which has a gate at each end. When the bucket descends upon the balanced platform *K*, the gates are moved into the position shown in Fig. 2 by means of the lever *J*, rod *I*, and arm *H*. As the gate 3 rises, the gate 4 descends and stops the flow of coal from the bin. When the bucket is lifted off the platform, the gates are reversed as shown in Fig. 1. The quantity of coal that may pass into the bucket is thus measured, at each filling, and is limited to the amount which is caught between the gates 3 and 4.

COAL GROOVING MACHINE.

No. 551,140. Edward S. McKinlay, Denver, Colo. *Patented Dec. 10th, 1895.* Fig. 1 is a side view of the machine, and Fig. 2 is a top view of the same. The machine is designed to cut vertical grooves in the coal, along the side walls or "ribs" of a room. The cutting is performed by a pair of wheels *I*, which are armed with cutters, as shown. They are revolved by means of a sprocket wheel *g*, and a chain *M*,



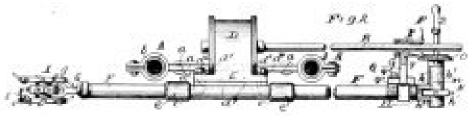


Fig. 2.

which is driven by a sprocket wheel *N*, at the rear end of the frame. The chain runs through the tubular frame bars *F*, and is well protected. Power is applied by means of the rotary engine *D*, square shaft *R*, and bevel gears *P* and *O*, to the rear sprocket wheel *N*. The frame is fed forward by the screw *S*, nut *S'*, gears *s* and *g'*, and handle 2. It slides through bearings *e*, which project from the saddle *E*. The saddle is supported by a pin *d'*, upon the lower bar *B*, and is clamped to the curved top bar *C*, by an adjusting bolt *d*. By slacking off this bolt, the cutter frame may be swung up or down, as desired. The bars *B* and *C*, may be secured at any height upon the posts *A*, by means of the clamp collar *A'*.

MINING MACHINE.

No. 550,283. Edmund C. Morgan, Chicago, Ill. *Patented Nov. 26th, 1895.* Fig. 1 is a side view of the machine, and Fig. 2 is a top view of the same. Fig. 3 is a front end view of the steadying device.

The cutter chain is guided by two sprocket wheels 44, 45, between the plates 42 and 43, in the usual manner, and is driven by means of the sprocket wheel 46, at the rear. The electric motor which supplies the motive power is constructed with a vertical spindle 11, having a pinion which meshes with the gear 13, thus driving the sprocket 46 by spur gears, instead of the bevel gearing usually employed. The frame 9, which carries the motor and working parts, slides upon the

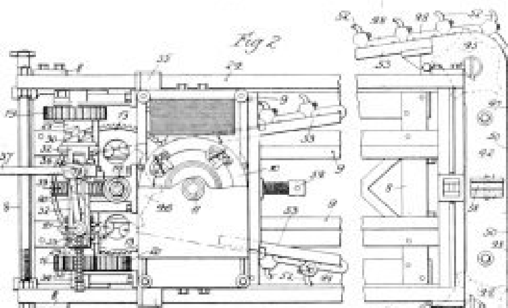


Fig 2

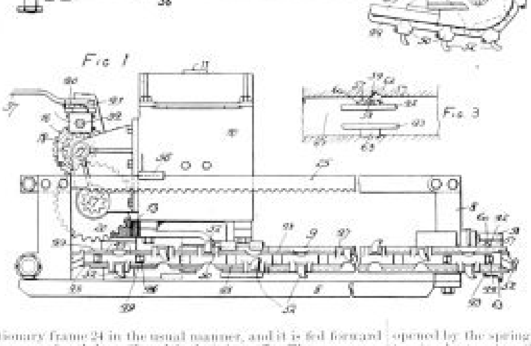


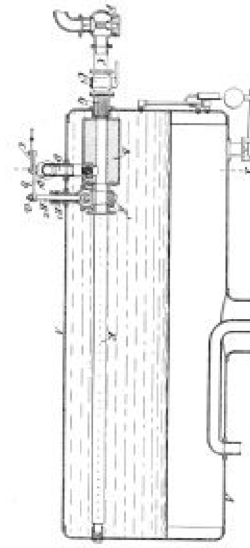
Fig 1

Fig. 3

stationary frame 24 in the usual manner, and it is fed forward by means of rack bars 25 and feed pinions 27. These are connected by suitable gearing to two clutches 28 and 29, on the shaft 17, which is rotated by the worm wheel 30 and a worm on the spindle 14. The clutches 30, 33 revolve with the shaft 17, and when coupled to 28, by means of the lever 37, produce a slow forward feed motion. When 29 and 33 are coupled they produce a rapid backward feed motion. The cutter head frame 42 is held steady against all side strains by means of a guide cutter 58, 59. As shown in Fig. 3, the cutting blade is inclined, so as to cut a V groove in the underside of the hanging coal. By this device the cutter is enabled to produce a guide groove which is smooth and solid upon the side on which the pressure is exerted, the splintering of the coal being confined to the off side of the cutter.

METHOD OF GENERATING STEAM.

No. 550,831. John H. Laird, London, England. *Patented Dec. 3rd, 1895.* In this device, the fuel is burned in contact with the water, and the entire amount of the heat developed by combustion is imparted to the water. The fuel, which may be oil vapor or spray, or any variety of combustible gas, is mixed with a sufficient volume of air to properly burn it, and is forced by suitable pumps through the valve *F* and

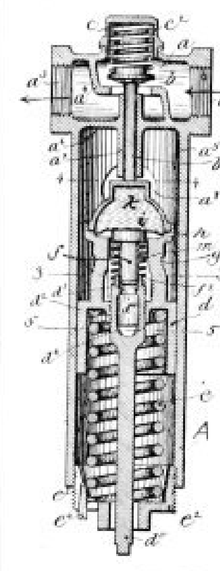


cock *C*, into a firing tube *B*. The hot products of combustion pass through the cock *E'*, into the perforated tube *E*, and escape into the surrounding water. The gas quickly cools to the temperature of the water, and rising through it in streams of bubbles, mingles with the steam. Thus there can be no waste of heat, as the entire operation of combustion and cooling is performed within the boiler.

The gas is ignited, at the start, by closing the cock *E'*, and opening another cock *D*, to the atmosphere, and holding a torch at the orifice *D'*. The lever *C* is connected so as to operate both cocks simultaneously. As soon as they are reversed, the fire passes into the tube *E*, and the generation of steam begins. *G* is a bundle of rods which act as a safety check to prevent fire from passing back into the supply pipe.

REDUCING VALVE AND STEAM TRAP.

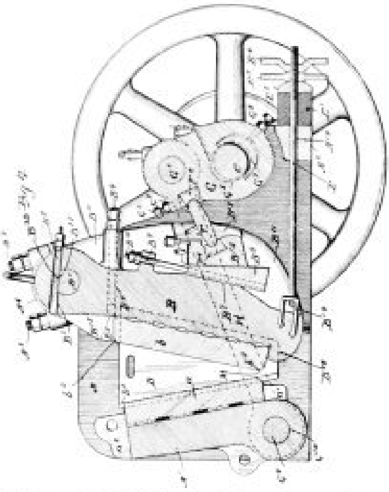
No. 551,778. William B. Mason, Boston, Mass. *Patented Dec. 24th, 1895.* The supply pipe is attached at a^2, and the steam passes through the valve *h*, in the direction shown by the arrows. The steam is throttled, and its pressure reduced



to any extent, as desired, by passing through the valve. The entering steam tends to force the valve to its seat, and the spring c^1 operates in the same manner. The valve is opened by the spring *c*, which may be adjusted to any desired tension by turning the screw plug c^2. The condensed water from the heating apparatus to which this valve is attached, enters the casing at a^6, and collects in the space above the piston *d*. This piston is fitted to move freely within the casing, and is not packed except by the water. The escape of the water is governed by a plug valve *f*, which is attached to the flexible plate *i*, forming the bottom of the cell or cup *k*. This cup is filled with naphtha, which is very sensitive to changes in temperature. When the case is filled with steam, the naphtha expands and shuts the valve *f*, but when the cup is surrounded with water, it contracts and lifts the valve. The opening of the valve may be adjusted by turning the screw $d^1 d^2$. The drip or waste pipe is connected in any suitable manner to the lower end of the case *A*.

ORE CRUSHER.

No. 551,304. Charles L. Carman, Chicago, Ill. *Patented Dec. 10th, 1895.* The movable jaw *B*, swings on a pin B^1, and is held back against the toggle links by the rod *E*, and spring E^1. The front jaw is not movable. Motion is given to the parts by the eccentric *C*, on the main shaft. The upper end

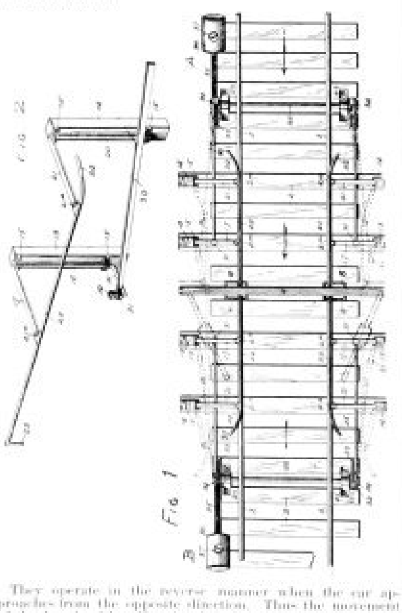


of the pitman *G*, is held by the pin G^1, and heavy side links *H*, which are shown in dotted lines. The pin G^1 thus has an up and down movement, and the bearing block F^2, which drives the toggle bar *F*, has a compound movement. It follows the pin G^1, up and down, and swings to and fro around the pin G^1, and is moved back and forth by the lateral motion of the eccentric. The motion which is imparted to the crushing jaw by this peculiar mechanism, is claimed to be so graduated that it is very efficacious for crushing tough ores.

MINE DOOR.

No. 551,786. Levi S. Minerd, Minden Mines, Missouri. *Patented Dec. 24th, 1895.* Fig. 1 is a top view of a pair of doors with all of the apparatus in place; and Fig. 2 is a perspective of the actuating bar and its supports.

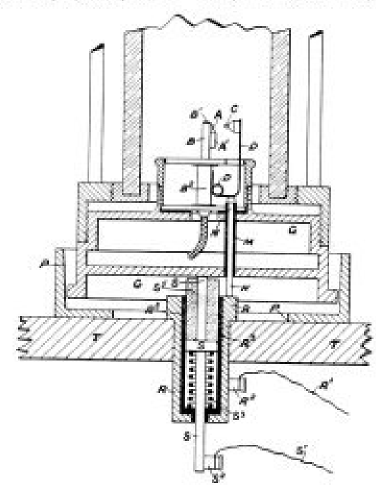
The doors are made in pairs, and are hinged to suitable frames or casings, at their outer edges. Each door is provided with operating bars, 22, there being one on each side. These bars are attached loosely to the doors by means of hooks 23, Fig. 2, which engage with long staples 8 upon each face of the doors. They are supported at a proper height by swinging arms or cranes 17 and 21, which are attached to posts 13 and 14. The doors are held shut by means of balance weights 36, upon the arms 35 of rockshafts 26, which are connected by pitmen rods 30, to short arms 18, at the foot of the cranes 17. Each weight pulls against the other, and they hold the doors firmly at the middle position, tightly closed. When a car approaches, as in the direction of the arrows, it strikes the bars 22, and pushes them forward and outward, as shown by the dotted lines. The weight at *A* is lifted, but that at *B* remains stationary, the pitman being slotted to permit the backward motion.



They operate in the reverse manner when the car approaches from the opposite direction. Thus the movement of the door in either direction is resisted by the full power of one of the weights, except for an inch or so at the middle position, when the weights pull against each other. These doors will yield to extra pressure from shots or explosions, and will promptly close, and maintain the air currents in a proper manner.

LIGHTING SAFETY LAMPS.

No. 550,309. William Ackroyd and William Best, Birkenshaw, England. *Patented Nov. 26th, 1895.* This device is designed for lighting safety lamps in places where explosive gas is present in dangerous quantities, by means of electricity, and without opening them. A carbon block *A* is fastened to the side of the wick tube *B*. A movable carbon *C* is held by a spring *D*, which is attached to a collar B^1, and is properly insulated from the wick tube. A conducting rod *N*, properly insulated by a covering *M*, passes down through the oil chamber *G*, and rests upon the brass cylinder *R*. Another conducting rod *S* touches the bottom of the oil chamber and is held up by the spring S^1. The cylinder *R* and rod *S* are

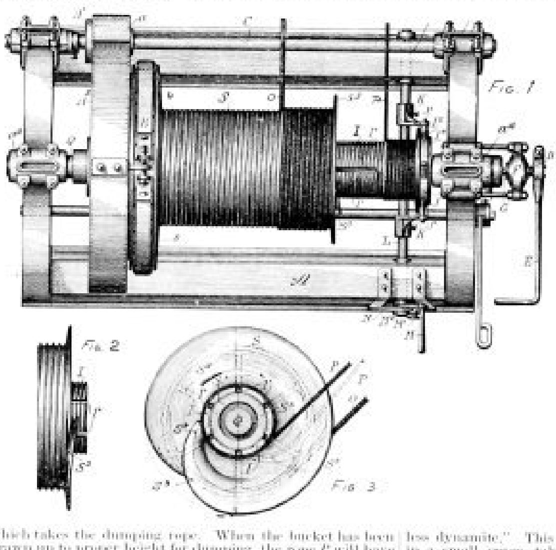


connected to the accumulator or dynamo, by the wires R^1, S^1. When it is desired to light a lamp, it is set down inside the ring *P*. The rod *N* strikes *R* and slides upward, thus bending the spring *D*, and bringing the carbons *A* and *C* together. As the current passes, the end of the wick is quickly warmed. The lamp is then lifted up, and as the carbons separate, the circuit is broken. The flash which occurs at the breaking of the circuit ignites the wick. As the carbons do not project above the top of the wick tube, they do not obstruct the light.

HOISTING AND DUMPING DRUM.

No. 552,513. Charles L. Carman, Chicago, Ill. *Patented Jan. 7th., 1896.* Fig. 1 is a top view of the entire drum and its attachments; Fig. 2 shows a part of the main drum; and Fig. 3 is an end view of the same.

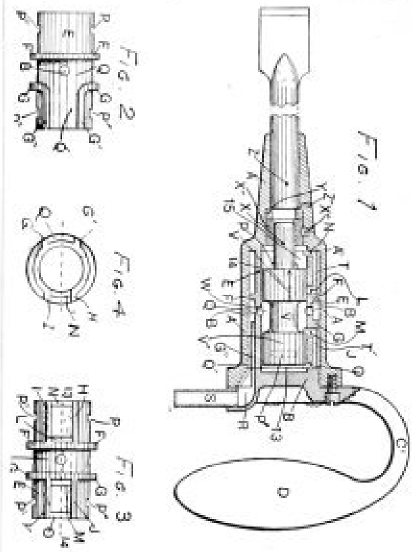
This apparatus is designed for hoisting coal, ores, etc., with a bucket which is to be dumped automatically at a certain point, in each lift. The bucket is hoisted with a "double fall" by the rope *O*, and the dumping is effected by the rope *P*. As the hoisting rope moves twice as fast as the bucket, the main drum *S*, is made twice the diameter of the drum *I*,



which takes the dumping rope. When the bucket has been drawn up to proper height for dumping, the rope *P* will have filled the small drum, and it will then run close to the end of the main drum. As the drums revolve, the rope will mount up the spiral guide S^3, and will wind onto the main drum, thus doubling its speed. The quicker motion thus given to the dumping rope, causes it to pull up much faster than the bucket raises, and enables it to release the catches or other dumping apparatus. The point at which the bucket will be dumped can be adjusted by sliding the small drum within the large one, by means of the collar *J*, arms *K*, rock shaft *L*, and lever *M*. The main drum is driven by a friction clutch in the usual manner.

PNEUMATIC HAND DRILL.

No. 551,687. William B. Murray, Chicago, Ills. *Patented Dec. 17th, 1895.* Fig. 1 is a lengthways section of the machine; Fig. 2 is a view of the under side of the cylinder; Fig. 3 is the top side of the same; and Fig. 4 is an end view. The machine is held up to its work by the handle *D*. The cutter or drill stem *Z*, is hammered upon the inner end, by the piston rod *X*, which is attached to the double piston *V*. The outer shell or casing *A*, is forged in one piece, and the liner or cylinder *E*, is also forged of steel. The exterior surface of the cylinder is formed with grooves and ridges, which serve to enclose passages for the compressed air, between the cylinder proper and the outer shell *A*. Compressed air is admitted through the pipe *S*, and holes *R* to the space between the pistons. The parts being in the position shown, the air will pass through the ports *M* and *O*, to the back end of the



piston. The piston will fly forward and strike the drill bar *Z*, and in so doing, will close the exhaust port P, and inlet port M_1, and will open the exhaust port P^1, and inlet port *L*. The air then passes to the front end of the cylinder and moves the piston back to the position shown. The blows follow each other with great rapidity, thus enabling the drill to cut continuously, as long as the machine is pressed up to the work. The handle bow *C* is elastic, and absorbs most of the shocks.

BLASTING CARTRIDGE.

No. 551,900. Paul A. Oliver, Olivers Mills, Penna. *Patented Dec. 17th, 1895.* It is claimed that this cartridge enables blasting to be performed in the presence of inflammable gas without igniting it.

The drawing shows a longitudinal section through a cartridge and its cap or primer, constructed according to this invention.

A is an outer inclosing cartridge case of any approved material. This case is filled with a flameless explosive compound *B*, preferably the kind commercially known as "flameless dynamite." This flameless explosive compound packs in a small space, takes up less room than ordinary black blasting powder, is a high explosive, and is set off by means of a cap or primer. This flameless explosive compound when exploded, will not ignite the gas in a coal mine, or air mixed with fire-damp or coal dust; but as it requires a powerful cap to set it off, it also becomes necessary that the cap itself should produce no flame; as otherwise the flame of the cap bursting through the blasting charge would ignite the gas in the mine.

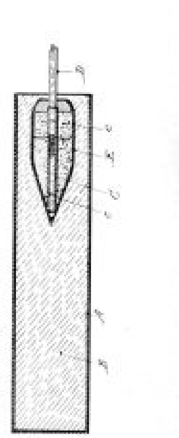
C is a metallic cap containing any approved detonating compound or fulminate, such as the fulminate of mercury *c*.

D is a fuse inserted in the end of the cap *C*. This fuse is preferably an electric fuse consisting of two insulated wires.

E is a case secured to the cap *C* and surrounding it, and *e* is a flame-extinguishing substance in the form of a dry powder, such as borax and bicarbonate of soda or alum and borax, contained in the case *E*, surrounding the cap, and interposed between the cap and the flameless explosive compound *B*.

The front end of the case *E* is preferably pointed to enable it to be thrust into the compound *B*, but it is not necessarily pointed, as the case may be packed in with the flameless explosive compound in a bore-hole, or it may be placed upon a rock and covered with the flameless explosive compound, and an outer layer of clay.

The ends of the case *E* and the cap *C* are plugged up in any approved manner, such as, for instance, with melted sulphur.



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PROSPECTING FOR GOLD.

THE PLACERS OF NORTH AMERICA.

The Location of Placer Deposits in Different Parts of North America and a Description of Their Peculiarities and the Methods by Which They Are Worked.

Written for THE COLLIERY ENGINEER AND METAL MINER by Prof. Arthur Lakes.

PLACER MINING FOR GOLD IN NORTH AMERICA.

As our prospectors are more likely to go prospecting in these days of gold in their own country of North America than elsewhere, we shall devote our time for the present to this country.

Although from an historical point of view the discoveries of placer gold at Sutter's Mill in California practically were the origin and main impetus of gold mining in North America, and would therefore be apparently the right place to begin with an historical and geographical account of placer mining, yet, for practical purposes, we prefer to begin with a geographical distribution of gold, commencing at the extreme Northwest from Alaska downwards.

THE PLACERS OF ALASKA.

In 1870, Dale, the explorer of Alaska, said that gold and silver exist in limited quantities in Alaska. Talcose and chloritic slates with veins of quartz abound in the island of Kadiak (see map). Analysis showed only $1 to the ton in gold and silver; but Newberry observes that "These specimens come from a system which at other points is probably much richer. The mineralogical character of the specimens is precisely that of the most productive gold bearing veins known, although silver will not be found in quantity in such an association of minerals." The gold bearing alluvion of Cook's Inlet was probably discovered from the same rocks or class of rocks.

The gold deposits of Stickeen river are in British territory, and are all placers, though gold veins exist. The head waters of the Taheo river have afforded coarse gold. Fine scaly gold, like iron filings, is found in the sands at the mouth of the Porcupine, or Rat river, a branch of the Yukon. The Kakun river has a yellowish gold bearing clay, and gold has been found in the bay on which the Taku villages are situated, averaging 5 cents to the pan in scales and small nuggets.

The richest deposit was on the main stream four or five miles from the bay, at the foot of a water fall 100 feet high. More recently quartz prospecting has been vigorously carried on in this territory. In parts of Alaska they work the gold gravel out in frozen blocks and pound it up and thaw it out in the spring. They work drift mining in this way all the winter. The gravel beds never thaw out in Alaska.

G. A. Carpenter in the Alaska *Record*, gives an account of the placers around Cook's inlet.

"Six Mile creek is the richest and biggest. It empties six miles east of Resurrection creek, opposite the head forks of the famous Kenai river. It is a large stream, 200 feet across at the mouth and 4 to 6 feet deep, with rapid current. Six miles up the hills the canyon begins to narrow from the bench lands until at the first forks, 12 miles up from the arm, the right hand fork, or Canon creek, foams and whirls between walls of slate. The left hand fork runs more smoothly in an open, rolling country. To the first fork there are large bars, which are hydraulic propositions, and the gold being fine on the water's edge, the worker did not average over $3.50 per day. On Beedy's bar three men took out in August 23 ounces of gold in 13 days with sluice boxes. They had put a wing dam in a short distance from the shore line. This was an immense bar, which to be properly worked, should be by hydraulicing. The largest and best property yet discovered is that of Sanford Mills, a prospector, who, with 100 pounds pack of grub and tools on his back, and no blankets, found gold on the creek at the upper sources, and after thorough prospecting proclaimed that Six Mile discounted Resurrection and Bear creeks for gold. He is at present ground sluicing a channel through the bar above high water mark to turn the creek into it next season and work the creek bottom. At the last end of the bar Sun was making $10 a day per man. There is more or less clay or cement in the gravel, so that the bank stands up from the creek about 30 feet and extends back like a bench land to a height of 150 feet a quarter of a mile from the creek. The creek bottom in front of Sun's claims catches the gold washed through two miles of box canon above, and pieces of gold can readily be seen through two or three feet of water lurking in the crevices. He expects to take out $100 to the man per day.

"Dusez and party, on the next claim below, took 2,000, and claimed that their sluice boxes yielded an ounce of gold per day to the man. The creek is all canyon with good hydraulic banks and small sniping bars to the second forks, 25 miles from salt water. The contents of a pan tied up in the corner of a red bandanna showed $8 in coarse gold, and next day they took out pieces worth $10 and $15, showing what the rich spots will yield. But a man going to Six Mile wants to have an adequate respect for the red and black moose gnats!"

BRITISH COLUMBIA.

From Alaska, next in order we turn to British Columbia. George M. Dawson says, "There is scarcely a stream of any importance in British Columbia in which

BRITISH COLUMBIA GOLD FIELDS (AFTER LOCKE).

the 'color' of gold cannot be found. Gold discoveries made in 1858 led to a great 'rush', and gold ever since has been the chief factor in the prosperity of the country. Between 1858 and 1880 the product, according to Locke, was $45,140,889. The gold yield fluctuates from year to year, due partly to the uncertainty of the deposits worked and to climatic conditions, great quantities of snow perhaps falling one winter, and more than an average rainfall in the summer preventing the clearing of the deep claims from water till late in the season. In Cassiar district the unfavorable spring prevented the miners from reaching their claims till late, and heavy floods impeded their operations during the summer.

"The very general distribution of alluvial gold over the province indicates that several different rock formations produce it in greater or less quantity. The coarse gold is most likely to be near original veins. 'Colors,' as the finer particles of gold are called, travel far along the beds of rapid rivers before they are reduced to invisibility. The gold formation proper, and in place, consists of talcose and chloritic, or greenish schists and slates, and are doubtless a continuation or equivalent northward of some of the rich gold bearing slates of California. From the denudation of these rocks and veins the gold has been concentrated in the placers. The greatest area of these gold bearing schists is in the disturbed region west of the Rocky Mountain ranges known as the Purcell, Selkirk, Columbia, Cariboo and Omineca ranges. Gold bearing rocks also occur near Anderson river and Boston bar on the Fraser, at Leech river, Vancouver Island, and elsewhere. The Cariboo, discovered in 1860, has been the most permanent and productive. The 53d parallel of latitude passes through this district, which has been described as a mountainous region, but is rather a remnant of a great high level plateau, 5,000 feet high, dissected by numerous tributaries of the Fraser, which cut great V shaped valleys. And with lessening slope the rock is concealed by gravel deposits which increase in thickness and extent till the valleys become U shaped, or flat-bottomed, and little swampy glades are formed, through which the stream flows tortuously and with gentle current. The steep banks are densely covered with heavy pine trees. The country is covered by drift or detrital matter, concealing the rock substratum. This description is characteristic of many of our placer localities also in Colorado.

"The shallower placers, as usual, first attracted attention, but later the deep diggings were found by far the most profitable, as in California and Australia. Williams and Lightning creeks have so far yielded the greater part of the gold of Cariboo. They were known from the first to be rich, but have been found to be specially suited for deep work in having a hard deposit of boulder clay beneath the beds of the present water courses, which prevents the access of much of the superficial water to the workings below. By regular mining operations, the rocky bottom of the valley is followed beneath 50 to 150 feet of overlying clays and gravels, the course of the ancient stream being traceable by the polished rocks of its bed and the coarse gravel and boulders which have filled its channel. In the hollow of the rocky channel the richest lead of gold is usually found, but in following the rock surface laterally, rich side ground is discovered of greater or less width." The old stream courses follow the same direction as the new and present rivers, crossing often from side to side of the valley, never leaving the old valley, or running across the modern drainage system, as is so often the case in the deep placers of California and Australia. The Van Winkel mine is a good typical example of the method of mining to reach the buried channels. The claim covers 2,050 feet length of valley, and the deepest part of the channel has been cleared out 1,600 feet long. The workings attain a width of 300 feet; $40,000 were expended before gold was found in the channel. Since, it has produced well, upwards of $15,700 in one week, and weekly "clean ups" of $14,000, $12,000, etc. In 1876 the product had amounted to $500,964. In reaching the buried channel a shaft is usually sunk at the lower down-stream end of the claim (as at Roscoe placer, Colorado) on the sloping side of the valley, where, after having gone through a moderate depth of clay or gravel, the slaty rock of the district is reached. The shaft is continued through this till a sufficient depth is attained, when a drift is started at right angles to the course of the valley. The old channel is thus struck in such a way as to enable the subterranean water collecting in it from the whole upper part of the claim to be pumped to the surface by the shaft. On cutting out of the slate rock, however, into the gravel, so much water is frequently met with that the pumps are mastered, rendering necessary a cessation of work till the dryest part of the season, or the application of more powerful machinery. When the drift is not found to be at a sufficient depth to cut the bottom of the old channel, it is generally necessary to close it, and after continuing the shaft to a greater depth, to drive out again. The old channel, once reached and cleared of water, is followed up its slope by the workings to the upper part of the claim, and where paying side ground occurs it is also opened. The average depth of workings is 70 feet. The water is raised to within 40 feet of the surface, where it is discharged into an adit 3,000 feet long. There are two pumps 10 inches in diameter. The richest pay is obtained in the rock channel of the old stream, but where this is much contracted, the force of the water has swept the gold away to those places where its width is increased. Most of the slates are rotten and crumbling to a considerable depth, and in clearing up in the bottom, a thickness of 1 to 2 feet is taken out with a pick and shovel (as in the Alma placer, Colorado), and sent up to the surface with the overlying gravel for treatment. In the side rock, as in the central channel, the greater part of the gold is found lying directly on "bed rock," and only occasionally are paying streaks seen in the gravel a few feet above it.

The side ground is worked up from the channel in successive breasts parallel to it. The average yield when Dawson visited it was 3 ounces to each set of timbers, the set uncovering about 35 square feet of bed rock with height of 6 feet. The lowest layers of gravel contain many large boulders of quartz and slate, not much water worn, which must have come down from the hillsides. It is a torrential deposit to a depth of 4 feet in the channel, above which the gravel is better rounded and more evenly spread, though still mixed with clay. Owing to the unconsolidated nature of the gravel, the pressure on the supports of the workings is excessive. The sets of timber are only a few inches apart, and workings are lined with complete lagging. The timber is massive, 1 to 2 feet thick, of the country spruce, costing 8 cents delivered at mine.

In many parts water streams from the roof like a heavy shower of rain. The gold gravel is raised to the surface by bucket rope with friction gearing and water power. The whole of the deep workings are annually filled with water at the time of spring floods and it is late in summer or autumn before the pumps acquire the mastery. This account of Dawson's gives an admirable idea of a typical mine of this kind not merely for the country in question, but for others similarly situated in regions far distant. In endeavoring to "bottom" the old channel on Lightning creek, great difficulties were met from the large quantity of the water and the increased depth of sinking required. The lowest part of the channel holding good pay has not yet been reached. Usually the "pay" was taken in these placers from the bottom of the deep channel. In some places, however, the gravel paid clear to the surface. In working over the deep ground in early days much was left that would even now pay handsomely, but cannot be found or reached on account of the treacherous nature of the moved ground filled with old timbering and water. Dawson thinks the quantity of gold still remaining in Williams creek, which has been worked over, is as great as that already obtained.

In most gold bearing countries the placers, though rich, lead up to mining the quartz veins whence the gold came. At present the placers have absorbed the labor of the miner. The Kootenai district, Omineca and New Cassiar are very similar to those of Cariboo. The greater part of the gold range especially toward the north is very densely timbered and covered with moss, peaty swamp, and tangled vegetation, great obstacles to the prospector, differing much from the bare slopes of California. The Cassiar mines much further north are worked at enormous disadvantage owing to being situated in an almost Artic climate where the soil is permanently frozen (as in Alaska) at a small depth below the surface on the shady sides of the valleys, with a short season during which the water courses are liable to floods disastrous to the mines, with supplies at famine prices. Its rich deposits, however, show the continuity of the gold belt of the country. On the Fraser river the gold occurs along the whole course of the river irrespective of the formation over which the river may pass. In Vancouver Isle the Leech river district yielded considerable gold over a short area; the gold rocks are the same as those of British Columbia. In Southern British Columbia the placer deposits lie on or in the vicinity of black slaty rocks, from quartz veins traversing which the alluvial gold appears to be derived. In prospecting, the extent and distribution of these slaty areas is important. The fissile character of these slates renders them easily permeable to waters which have concentrated the minerals of economic value with quartz and other minerals of secondary origin in the veins. These slates are probably metamorphosed mesozoic shales, some of the gold may be derived from igneous Tertiary rocks. On the Tranquille river, flakes and scales of platinum are found together with flakes of gold. In so many cases it is recorded that along these rivers the best paying ground was found where the aforesaid slates crossed the river, that too much importance cannot be given to these slates. Gold has been found in gravels resting on the surface of the old rocks in irregular pockets formed by the uneven hollows into which they are worn. Were the underlying rocks or stream bed a coarse conglomerate instead of a clayey breccia and clays and shales, it would probably form a rich gold bearing horizon.

In the Queen Charlotte Islands in 1849 the Hardas Indians brought rough gold to Fort Simpson; their mode of obtaining it was to light fires over the vein and dash cold water on the heated rock which was thus disintegrated and made to expose the metal.

A correspondent of the San Francisco *Call* writes from Vancouver lately that there is a gold excitement in that region. In the Cariboo, British Columbia, hydraulic companies in finishing up their season's work reported $67,000 from a late clean up at the Horsefly and Cariboo mines. On the Waverley claim bedrock has just been struck after 18 years of quiet steady working by poor miners. Rich placers are reported on the Yukon river. The largest nugget taken out last season in Alaska was on Glacier creek. It was worth $234. The principal jingle on the store counters and bars is gold dust. A miner will go into a place of public resort where dancing is the high carnival and balancing the scales with $50 in dust he will receive dancing tickets at 50 cents each for that amount and the whole house, bums, broke miners and all fill up the sets until this amount runs out, when another miner with a long sack steps up to the bar and lays down his dust for another supply of tickets and thus the long winter hours of darkness are spent.

A PROSPECTORS' ACCOUNT OF THE GOLD REGIONS OF THE NORTHWEST.

The latest and most comprehensive sketch of the mining possibles of all this northwest region was given me by a friend, Mr. A. L. Preston, who has just returned from a general survey and prospecting trip over Idaho, British Columbia and part of Alaska. In Idaho on the Snake river, placers are being worked on bars at the surface line of low water. The gold is fine, light and hard to save. At Spokane many machines of various patterns are in use, the river valley is of barren wastes of sand. The banks are low and they are working long bars washed up on bends and islands down to the water line. The soil is alluvial with no glacial matter. Pumping plants are a necessity, as there is no head or gravity line to the rivers.

In British Columbia it is claimed gold can be found in every stream. The Columbia river is 35 feet deep between high and low water mark during six months of the year. North of Revelstoke the Columbia river rises near the United States boundary line west of the Rockies. It makes a sharp bend cutting through the Selkirk range and goes south 300 miles. The first gold worked in paying quantities is 40 miles north of Revelstoke on small streams coming in from the east, and thence north, every stream from the east side contains placer gold as far north as Gold stream 75 miles north of Revelstoke. The country was first prospected in '59 and has been worked for the last 7 or 8 years. The altitude of Columbia river is 2,000 feet above the sea, the higher ranges 8,000 feet. Glaciers extend down to a level of 4,000 feet and are still working and grinding down rocks and gold. The best pay has been found late in the season at the foot of these glaciers. The side streams as well as the Columbia are raging torrents from June 1 to September, but they are worked between thawing out in April and the floods of May, also in the fall in September after the floods have run off and before the hard freezing of October. This high water is caused by melting of snows by warm weather. Rain usually lowers the water in the streams because it makes the mountains so cold that it checks the melting of snows, and the highest water is during clear, bright hot weather. Thus the snow rather than the rain is the cause of rise or fall of the rivers.

The gold is fairly coarse and found mostly on bedrock near the bed and channel of the present streams, also at the bottom of boulder and glacial debris to a depth of from 20 to 80 feet. In proof of what may be found there, the Last Chance placer worked four years digging down to bedrock, sixty feet, with a river of water to contend with, only a few months in spring and fall available for working, the works drowned out in summer and frozen up in winter. The prospectors made their own wooden wheels and pumps, packed everything over a rough trail 75 miles on mules. They had to make bridges across streams which were liable to be speedily washed away again. For supplies they would make two or three trips in the summer season. They drifted the first season in bedrock, hoisting the dirt to the surface and washing it in a common sluice box. In the brief season they took out $7,000 and the following year $10,000 and the past year the same. On Smith creek on the west side of the Columbia an attempt was made at hydraulicing with canvas hose and an old fashioned brass nozzle like a fire hose and fifty feet head of water power.

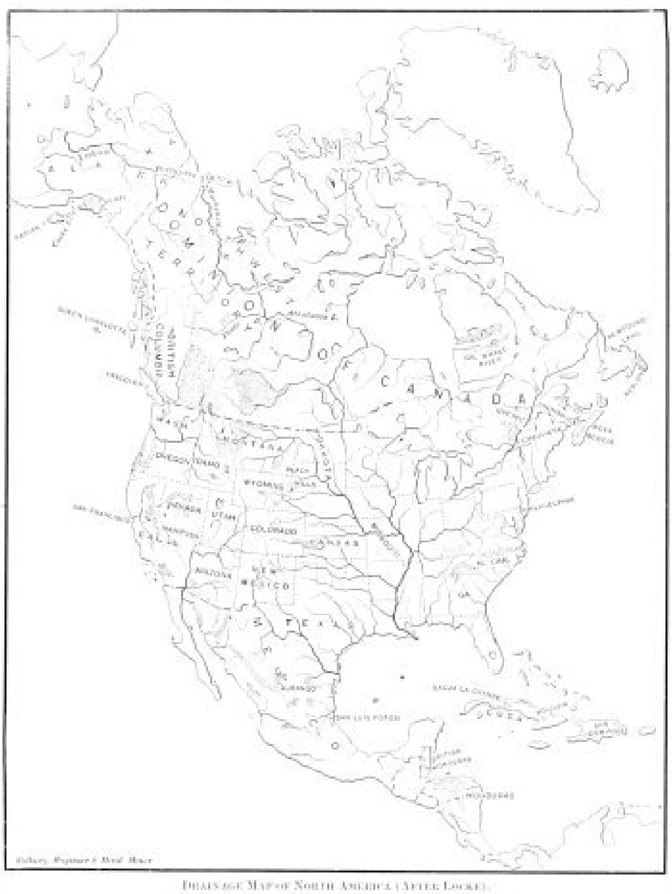
They are working, however, on a bench not a well defined channel and the material is all glacial drift full of immense boulders.

Up to the head of Smith creek there are evidences of remains of quite extensive ground sluicing done in the 60's and they have worked up almost under the present glaciers. Prospecting done here during the last few years has given fairly good returns, but no work of any importance. "Outfits" of 3 or 4 parties are working about a dozen men each on Smith creek and about 60 men on Gold stream trying to get down to bedrock and getting a little pay as they go. North of this a little surface placer work is being done. Mr. Preston met a party of four who had been on a canoeing journey up to Big Bend and Canoe river to latitude 53 N. who reported small prospects and no diggings. The country between Selkirk range and the Rockies is characteristic of mountain ranges. The strike is west of north and south southeast parallel with the Rockies. The formation is like that of our Rocky Mountains consisting of granite, porphyry, rhyolite and other igneous eruptive rocks.

The mountains are steep; the lower slopes are covered with heavy timber, tamarack, fir, etc. Wash and slides and great glacial slides and moraines are characteristic. The first glaciers Mr. Preston met were south of Revelstoke, narrow necks of ice leading up to big basins full of ice. One of these glaciers is 400 feet deep. The veins in this region have not been much prospected. There are a few rich and narrow veins with free milling quartz carrying gold. There are no large mines there. Farther back on the Selkirk range, 30 miles east of Columbia river, arsenical pyrites are found carrying gold and silver, principally gold, and 30 miles on the west side near the top of the range we find galena and silver ores.

Kootenai country lies east of the Columbia and between the Canadian Pacific railway and the boundary at the end of the Selkirk range. Galena and silver ores are principally found north of Spokane country. The region is steep and rugged. It is a great region for snowslides. A number of large mines are being worked here rich in silver averaging from 300 to 500 ounces silver to the ton.

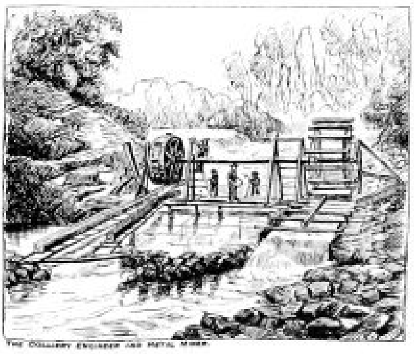
At Pilot bay on the Kootenai lake is a smelter, and another at Nelson and a third at Trail landing on the west side of the Columbia. Trail creek district runs west ten miles and borders on the state of Washington and extends north as far as it has been prospected for 30 miles. The camp of Rossland is the center of this Trail Creek district and is located 6 miles north of this boundary line and some distance west of the Columbia river. The ores are hard, being arsenical pyrites carrying one to three ounces of gold with 10 per cent. copper and some silver. Veins of this ore occur in the granite and the ore is found frozen onto the walls. There is no gouge or gangue and no distinct line between ore and country rock. Only two veins are opened up east and west along low ridges north and south of Trail creek. On the north side the Le Roy mine and War Eagle, the Jose and O K between them, are shipping 200 tons daily principally of gold ore about 2 ounces of gold or $50 per ton. Boundary creek, 40 miles west, reports a number of prospects similar to this Trail Creek district. This mineral belt extends south into Washington and Idaho. The new camps are being pushed ahead. Prospecting is hard work. The country is heavily and closely timbered with much underbrush and fallen timber. The prospector has to pack his tools on his back and cut his own trail through the wilderness; when he finds a favorable location he makes his central camp and works from that. Game is not plentiful. In the veins they find a "cap rock" rusty with oxidized iron broken over



DRAINAGE MAP OF NORTH AMERICA (AFTER LOCKE).
DOTTED PORTIONS SHOW POSITION OF PLACER GOLD DEPOSITS.

and capping these veins; this cap is two to four feet deep. Then the rock passes into hard unoxidized pyrites. Prospecting is hard and slow, for you have to blast from grass roots; caps are poor; the best ore is found with depth.

The Fraser and Cariboo districts lie west of this region. At old Cariboo up to the Fraser this last season a rich company has put in two expensive hydraulic plants, one on the Quesnal, the other in the south fork of the Horsefly, putting forty or fifty miles of ditch on each plant, also several thousand feet of steel pipe and large siphons. Several storied reservoirs are being got ready for extensive hydraulicing next season. They report gravel banks 30 to 60 feet deep and gravel ranging 50 cents to $2.00 per yard. The difficulty outside of the short season is from the immense glacial boulders. Farther south on the Fraser river Indians, white men and Chinese are washing bars every fall and spring at low water, with rockers, sluices, etc., making a living. A San Francisco company have gone on the Middle Fraser north of Yale and have put in dredging plants at



DRAINING A RIVER CLAIM BY A CALIFORNIA PUMP.

an expense of $75,000 per dredge, dredging up sand and gravel fifty feet below the water surface. In Horsefly country which has been worked since 1860 successfully, they will put down a wing dam or caisson to bedrock and clean up well. Throughout British Columbia transportation is by horse; they use canoes where they have lakes or can go down stream, but the streams are too swift to ascend that way. Leaving the traveled trail you have to carry things on your back; trails have to be made and prospectors carry big crosscut saws for this purpose and saw through the timber and fallen logs.

CANADA.

The gold alluvions of lower Canada cover a large region, upwards of 10,000 square miles. The gravels through which the gold is irregularly distributed are covered by vegetable earth and sometimes clay. They lie upon metamorphosed Lower Silurian rocks such as schists associated with diorites and serpentines which are traversed by numerous veins of quartz. On the Chaudiere river at the Devil's rapids, where the river makes a sharp turn, gold has been found in the cavities, fissures and cracks of the clay slates which form the bed of the stream and act as natural riffles. At low water the country people break up these rocks and search them to a depth of several feet. The fissures are filled with clayey gravel in which the gold is met; and metal worth several dollars has been found between the layers of slate. The gold in these slates is sometimes tarnished by a black earthy coating of oxide of manganese. The richest slates lie near a quartz vein and the largest pieces of gold are found in its vicinity along the tributaries of the Chaudiere; it is worth observing that those very gold bearing eruptive rocks, diorite and serpentine (an alterative product of eruptive rocks) pave the stream together with schists, and gold is found in their vicinity. Pans yielded grains of gold and black sand or magnetite, a common accompaniment of the gold here as elsewhere. Dr. Douglas obtained 8 to 9 ounces of gold in 20 days from gravel accumulated in the re-entering angles and cracks of the diorite. If in this region, however, the gravel does not rest on bedrock but on a bluish clay the alluvions overlying the clay are generally barren or poor. A section of a placer shows on the Chaudiere:

1. 1 foot of sandy vegetable soil.
2. A yellowish sand with pebbles.
3. A clayey gravel containing gold.
4. Sandstone bedrock in the fissures of which the largest amount of gold was obtained.

In lower Canada they work subterraneously the alluvions during the winter season when most other placer operations are frozen up and closed.

"By the aid of pits and galleries the miners were able to carry on their search for gold throughout the winter and to extract and wash a large quantity of gravel in which the gold was so abundant as to richly repay their energy and perseverance. A mass of gold weighing over 1 lb. was found on the Gilbert. The pits were opened on the left bank of the river at distances of 50 to 100 feet from the stream and sunk to bedrock a depth of 20 to 25 feet. They were connected by galleries, one of which draining the whole of the works carried the water into a pit whence it was pumped into the river. The gold gravel was washed in rockers at the bottom of each pit, the greater part was extracted from fissures in bedrock, sandstone and clay slates which they break up to a depth of 5 or 6 feet. In its joints and between its lamina, where the gravel has penetrated and become hardened, gold has been found in greatest abundance and largest masses. Here as elsewhere the layers of alluvion which contain the precious metal are not continuous, but occur in sheets or belts of greater or less extent and of variable thickness.

"The proportion of gold in these sheets or belts is far from uniform and regular, the richer portion being met with in patches more or less remote and isolated from each other. The gold gravels result from a general alluvial action. In the veins on the hills from which the gravels are derived gold is often so capriciously and irregularly distributed that the results of a week's working in some favored spot may compensate the miner for months of unprofitable work in poorer ground." It would appear that in Canada the source of most of the alluvial gold is derived from the veins in the Lower Silurian rocks. In these slates quartz veins abound and in the black schists as on Leech river. The veins are very numerous, but generally very small. A vein of slates is often characterized by small thin streaks of quartz and little lenticular bunches through all its layers without showing any well marked large vein. This is characteristic of veins and veinlets in most slate regions, the quartz having a tendency to scatter through the minute cracks and interstices of a slate formation rather than to occupy a broad, well-defined fissure.

In addition to this there are the eruptive diorite or greenstone rocks worthy of observation as undoubtedly a source of gold in this as in many other regions. In Arizona we have ourselves observed such greenstone dykes to be decomposed and traversed by numerous little veinlets of gold bearing quartz. The oxidation of the iron pyrites in such formations yields the rusty surface float or gossan which sets the gold free; and from the wearing down of this soft oxidized material doubtless a large proportion of the placer gold is derived. On Leech river a large mass of these quartz veined slates has been worn down and removed during the excavation of the valley, leaving the heavy gold by a natural process of concentration in a narrow line in the bottom of the excavation. A cement also occurs on Leech river, sometimes far up the slopes, and in the river forms a false bottom with gold on top of it and gold below it on bedrock. Miners should not stop on these false bottoms, however rich, but go through them till they have reached bedrock where the best gold is almost sure to be found.

MANITOBA.

Gold is found along the Saskatchewan river and gold is found scattered over the surface from Lake Manitoba to the Rocky Mountains. On ascending the river granitic and crystalline boulders die out gradually and with them also the gold, showing that the gold is associated with and derived from these crystalline rocks.

NEW BRUNSWICK.

Gold has been found in the Carboniferous conglomerates of the coast. Here is another case of gold occurring in consolidated bodies of pebbles or conglomerates of a far older date than the ordinary placer beds. As these pebbles were originally derived from the granitic rocks the beds may be considered as an ancient consolidated placer. Alluvial deposits of gold have also been found in the counties of Central New Brunswick which show that the gold is derived from quartz veins penetrating the rocks of the district as also shown by the character of the pebbles.

NEW FOUNDLAND GOLD DEPOSITS.

Gold quartz veins are found in serpentine in the Lower Silurian rocks, and where no serpentine exists it is no use to look for ore. Serpentine, be it said, is usually a grass green or purplish rock of magnesian silicate derived from the alteration of certain minerals composing some igneous rocks. The area of this serpentine is 500 square miles. The ore occurs in beds or pockets rather than in veins, or in quartz knobs at the junction of little veins. So far we do not hear of extensive placer deposits.

NOVA SCOTIA.

In Nova Scotia there has been as yet but little placer mining, although there are large areas of drift and a great number of gold bearing lodes to which attention seems hitherto to have been almost wholly confined. The rocks are principally Lower Silurian. It is a curious fact that here gold occurs in spots and bunches up to 60 oz. nuggets in the veins. At Cooper lake a layer of tough clay and glacial drift was met with underneath the mud and vegetable matter and in the under clay small round gold nuggets.

SUMMARY OF NOTES ON THE NORTHWEST.

The principal points to note for practical use in this account of the gold deposits of the Northwest are:

1st. That in Alaska, and generally through this northwest region, talcose and chloritic or greenish and dark schists and slates abound traversed by veins and veinlets of quartz together with igneous dykes of eruptive diorite or greenstone. These rocks seem to be the parents of the placer gold and should be followed and traced with a view to those deposits.

2nd. Rich deposits of gold were found in Alaska at the foot of a waterfall. Singularly enough this is by no means as common an occurrence as one might expect.

3rd. Prospectors going to Alaska will have to encounter frozen soils and an Arctic climate, but their labor may be rewarded by the richness of the soils. They appear there to sometimes turn the course of the creek by wing dams one season to work the bed of the creek the following one. Black gnats and mosquitos are to be expected.

4th. British Columbia seems to be very rich in placers all along its rivers. Here again climatic conditions are a drawback. If you find course gold in placers in this as well as in other regions you are likely to be not far from the original gold vein and should look for it.

Another difficulty to the prospector is the dense forests overlying what he is looking for.

A V-shaped sharp canyon usually has a rapid stream in it which does not deposit much material; this is rather to be looked for when the canyon widens out into the U shape. Shallow placers will first attract the prospector, but it will be well when he has exhausted these to dig down and look for deeper channels and not let up till he has reached bedrock where he may expect most gold; side ground may be rich as well as central channel. The example of the Van Winkel mine is a good one to study and follow.

You may expect to be troubled with water and need pumps.

Do not stop at bedrock, but dig down into it; it may be five or six feet deep till you find no gold. Experience in this region and elsewhere shows that much of the gold is carried down into the chinks and crevices especially in slates.

Moreover the bedrock is liable to be rotten for a depth of a few feet and may pay to take out bodily and overhaul at leisure.

Unconsolidated gravels in the Van Winkel press heavily on the ground below and need thick timber supports.

The workings are annually filled with water and need pumping out every year.

Gold may be only found at bedrock, but may pay clear to the surface.

Work out your placer thoroughly and carefully whilst you are at it. It is very dangerous as well as difficult work to go over an old extravagantly worked ground again, and to work under moved ground, far more difficult than in virgin ground. At the same time it may pay to go over an old placer that was wastefully and carelessly worked by others years ago.

Good pay and placers may sometimes be found at the foot of living glaciers in this region.

The season for work is very short, but big sums may be made at times in a short season or by keeping at it for many years till bedrock is reached.

Prospecting in British Columbia is evidently "no picnic." You will expect to meet in that region enormous slides and moraines of rock from glaciers, as well as huge boulders, the latter are always an obstruction. The value and importance of these placers of the Northwest is shown by the enormous ditches and plants that are in preparation at so great expense.

In Canada the Silurian rocks, slates and schists appear responsible for the placer gold, together with diorite and serpentine.

It is important to notice that the Canadians have been able to carry on certain placer work successfully through the winter months, when elsewhere most placer miners give up.

We must not expect a placer ground to be continuous, or to carry the same amount or even any gold at all, thoughout its extent. Placers are often long, lenticular beds or bodies distributed at intervals, some gold bearing, others barren and others a mixture of both.

Gold quartz veins in slates are apt to be small and much scattered, but such veinlets are usually good indications of gold.

Early prospectors generally pay most attention to placer deposits and later, to veins in place. In Nova Scotia it seems the other way.

Finally it would appear that the Northwest is the paradise of placer deposits. The reason of this is to be looked for largely, in that region being the main area of the great ice sheet of the glacial epoch as well as the locality of many long glaciers and of a vast river and drainage system. We might conclude like Horace Greeley with our advice to the prospector: "Go Northwest young man."

Watt Mine Car Wheels.

The Watt Mining Car Wheel Co. of Barnesville, O., have an advertisement in this issue of our paper to which we wish to call especial attention.

This firm believe it better to do one thing and do that right than to be engaged in a variety of work. Acting on that principle they decided there was a good opening for a wide-awake firm to engage in the manufacture of mining cars and car wheels. They therefore organized a company for this express purpose and their phenomenal success shows they were right, as they today do more business in that line than any other firm in the United States.

The firm is composed of the four Watt Bros. of Barnesville, O., and Rev. W. K. Pendleton of Florida. The Watt Bros. are all practical men, having been brought up in the foundry and machine business, and two of them are inventors of many valuable articles that the firm are now manufacturing, all pertaining to their self-oiling wheel and their cars. They do all their own traveling and watch the interests of their patrons very closely. One of the brothers has especial charge of the foundry department and gives his undivided attention, watching every detail, and with such good results that their work is known all over the United States where there are any mines, with the exception of the anthracite regions. This trade they have never canvassed, but they are well prepared to do anything for this field and at low prices.

Steam Boilers.

The reports we receive from Messrs. H. E. Collins & Co., of Pittsburg, Pa., sole sales agents for Cahall Vertical Water Tube Boilers, manufactured by the Aultman and Taylor Machinery Co., of Mansfield, Ohio, evidences two things: First, that they have an exceptionally efficient boiler, and second, that Messrs. Collins & Co. are "hustlers."

Their latest report states that the following sales were effected within the last few days:

One thousand H. P. for the Pittsburg Plate Glass Co., Kokomo, Ind.; Brown & Co., Pittsburg, 100 H. P.; Jones & Laughlins, Ltd., Pittsburg, 500 H. P. The boilers for the Pittsburg Plate Glass Co. are of the standard direct fired type; those for Jones & Laughlins will be equipped with the chain grate stoker, and that for Brown & Co. is of the waste heat type.

INGENIOUS MINING CONTRIVANCES.

This department is intended for short and plain descriptions of unpatented ingenious contrivances or methods used at mines and found of value. When necessary, articles will be illustrated with cuts, if the writer will send a clear pencil sketch from which our artists can make the necessary drawings.

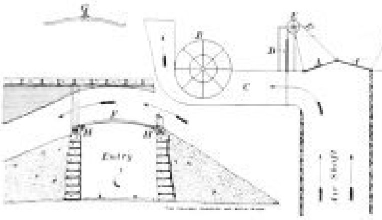
If the ideas are clearly expressed we will make all needed corrections in composition.

All accepted articles will be paid for at the rate of $5.00 per column, payable in any books in our catalogue, or that of any other publishers.

Balanced Doors and Iron Air-Bridges as Preventatives of Disastrous Mine Explosions.

(By Captain Wm. M. Morris, Pueblo, Colo.)

Since the explosion at the Vulcan Mine at New Castle, Colo., in February, when fifty-five men lost their lives through the same old story of carelessness, ignorance and bad discipline, with gas, coal dust and blown out shots, I have given some study to the question of preventing, to a great extent, such disasters. The destruction of the fan and over-casts (or, more properly speaking, air-bridges), by almost every explo-



sion, thereby destroying ventilation and preventing the rescue of the unfortunate workingmen, can be prevented by the plan illustrated in the accompanying sketch.

Balanced doors, *A A*, are set over the top of the air-shaft and the fan, *B*, is set about 50' from the shaft and connected therewith by a fan drift or tunnel, *C*. The balanced doors set over the air-shaft should be connected with the vertical door, *D*, by a wire rope, *E*, over a pulley or wheel, *E* and a rod, not shown in the sketch, should be connected with the throttle valve of the fan engine. When the least extra pressure of air comes up the air-shaft the balanced doors immediately open and the vertical door drops, thereby closing the fan and allowing the force of the explosion to go up straight into the atmosphere, and the lever or rod connected with the throttle valve shuts off the steam and the fan stops. As soon as the force of the explosion is over the doors can be closed by a slight push and the fan started, thereby restoring the ventilation. It will not make any difference whether it is a pressure or exhaust fan, as the explosion will go against the air as well as with it.

The air bridge I propose is shown at *F* and should be of boiler iron cambered to any degree desired. For wide bridges two or more plates can be bolted together with angle-irons, as shown in *G*. For small over-casts one wide plate will be sufficient. The ends should be strengthened by angle-irons spiked to a piece of 8" x 8" timber, which must be secured and fastened into the sides or over-head as shown on the sketch at *H H*. The iron should be from ⅜" to ½" thick, the thickness depending on the size of the bridge or over-cast. This type of a bridge or over-cast can be fastened so that it will take a great power to blow it out and it can be put in place quickly and cheaply even if knocked out. The iron must be tarred to prevent rusting.

Replacing Mine Cars on Track.

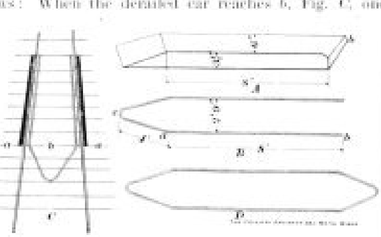
(By S. J. Roulledge, Pratt City, Ala.)

It sometimes happens that at certain points on slopes or haulage roads more wrecks will occur from derailment of cars than at any other point. Such wrecks can be prevented, and much expense and labor can be saved by adopting the arrangement shown in the accompanying illustration. It will work well at any place on a haulage road or slope.

By reference to the illustration, it will be seen that Fig. *A* represents a piece of timber about 8' long, 6" wide, 3½" thick at the outer edge, and 3" thick at the inner edge, or the side next the rail. The end of the stick is wedge-shaped, as shown in the figure. This wedge-shaped end is set in the direction from which the car or cars are being hauled, *a*, Fig. *C*. The entire stick is covered with plate iron 6" wide and ¼" thick.

Fig. *B* represents an arrangement of rail, made from same size rail as the track. The straight sides, from *a* to *b*, are each 8 ft. long. The distance *b* to *c* is 4 ft. The arrangement of the various parts is shown in Fig. *C*. The gauge of the track *b*, or in other words, the distance between straight sides of Fig. *B* is 2 ft. 9 in., for a 3 ft. gauge haulage road. If the gauge of the haulage road is more or less, the gauge of the track *b* must naturally vary.

The mode of operation of this arrangement is as follows: When the derailed car reaches *b*, Fig. *C*, one



wheel will mount the rail at *a*, and the other will mount the block. As the block is ½ in. higher on the outside, and the straight rail of the interior track pushes the opposite wheel, the car will pull on the haulage track. It makes no difference which side of the track the derailed car is, the result will be the same. In tail rope haulage, both empty cars going in and loaded cars going out can be replaced on the rail, by having the pieces of timber wedge-shaped at *both* ends, and making the interior rails as shown in Fig. *D*.

The thickness of timber and iron plate is for 30 lb. T-rail.

ELECTRIC MINE HAULAGE.

That the most economical method of bringing coal from the working face in a mine to the breaker or tipple is by means of some type of mechanical haulage, has long been recognized. The first system employed for this purpose was the steam mine locomotive, which was only applicable in such mines as were free from gas and which used the main haulage road as a return airway. The next system introduced was rope haulage, either of the endless or tail-rope type. These, with compressed air locomotives and electric locomotives, are now in use, reducing the cost of mine haulage very materially.

In many cases electric haulage proves most advantageous owing to the simple manner in which the

JEFFREY ELECTRIC MINE LOCOMOTIVE WITH LOADED TRIP.

motive power can be conducted to any part of the mine, and it can be utilized, not only for haulage, but for running the pumps, inside hoists, mining machinery, etc., etc. The accompanying illustration of an electric locomotive hauling a loaded trip to the tipple, shows very plainly the convenience of this system of haulage. The photograph from which this cut was made was taken at the mines of the Pulaski Iron Co. at Eckman, W. Va., which was recently equipped by the Jeffrey Manufacturing Co., of Columbus, Ohio, with a complete plant of coal cutting, drilling and electric haulage machinery.

This locomotive does the entire hauling and gathering of the loaded cars along the butt and main entries, hauling the coal to the top of an incline. The tracks at the mouth of the mine are so arranged that the locomotive makes a flying switch, cutting loose from the loaded trip, allowing the latter to continue to the top of the incline, while the locomotive runs down to the empties, takes them in the mine and distributes them to the various points where they are taken by the miners into the rooms.

We understand that the Jeffrey Manufacturing Company has built quite a large number of these locomotives during the past year, having equipped in all some fourteen or fifteen different plants. This company has also under construction locomotives for a number of coal mines in Pennsylvania, West Virginia and ore mines in Arizona. These locomotives are built in all sizes from 15 horse-power up to 175, and for all gauges from 18 inches up to the standard 4 feet 8½ inch gauge.

Personals.

Messrs. E. E. Olcott, Percy L. Fearn and Robert Peele, have opened offices as consulting mining and metallurgical engineers at 18 Broadway, New York. Gold and silver mining are their specialties.

Mr. H. C. Zacharias, formerly resident engineer of the P. and R. C. and I. Co., and superintendent of the Silver Brook Coal Co., but now superintendent of The Peerless Coal and Coke Co., at Vivian, West Virginia, has been visiting his old home at Shamokin, Pa.

Mr. Thomas B. Rickford, an American mining engineer, was murdered on Feb. 29th near Jiminez, Mexico, by Evaristo Rodriguez, superintendent of the Aurelio mine. Mr. Rickford, it is said, was examining the property prior to reporting on it.

Mr. Chas. C. Jones, B. S., has resigned as general manager of the Coeburn Colliery Co. at Lotus, Va., and has removed to New Orleans, La., where he will be located for some months. Mr. Jones was one of the pioneers in the development of the Wise county coal field. His removal to New Orleans was due to the recent death of his father, Prof. Joseph Jones, M. D., of Tulane University, New Orleans.

Mining Machinery Ordered.

The Robinson Machine Co. of Monongahela, Pa., inform us that their shops are busier than they have been at any time for the past three years. Among the late orders received by this company are the following: One pair Robinson standard type single drum friction engines for the Pacific Improvement Co., San Francisco, Cal.; one standard type double tail-rope engine for C. Jutte & Co., Pittsburgh, Pa., (being second order within the year); one standard type double drum tail-rope engine for Frank Armstrong, Pittsburgh, Pa. (being second order from this firm); complete tipple equipment for the Rock Run Coal Co., Camden Pa.; one 25' ventilating fan, of the Guibal type, for the Johnson Coal Mining Co., Columbus, Ohio; one 20' fan for the Essen Coal Co., Pittsburgh, Pa.

Several features of the fan under construction for the Johnson Coal Mining Co. are worthy special mention, viz.: the fan and machinery is in no way attached to the building, but is supported by heavy cast-iron "A" frames bolted directly to the masonry, thus keeping the machinery in perfect alignment besides furnishing a rigid support for the fan and machinery. The building is of steel throughout, and is absolutely fire-proof. The Johnson Coal Mining Co. has spared no expense to make this the most indestructible and perfect mine ventilating fan yet erected by any firm.

A Handsome Souvenir.

The Jeffrey Manufacturing Co., of Columbus, Ohio, presented a handsome souvenir to the members of the American Institute of Mining Engineers who attended the recent Pittsburg meeting. The souvenir consisted of thirty-eight fine half tone plates of mining, elevating and conveying machinery constructed by the Jeffrey Co. The plates were beautifully bound in dark red covers of artistic design.

VALUABLE STEAM APPLIANCES.

Types of Valves, Which Automatically Control Steam Delivery.

In this age of economy and efficiency in the production of any staple commodity, it is absolutely necessary for managers of mining and manufacturing establishments to be well informed as to such appliances as will tend to make possible the most economical and efficient utilization of steam. The old idea that fuel at coal mines "costs nothing" is recognized by mine managers as being radically wrong. At metalliferous mines fuel is usually an expensive item. Again, the large and generally lengthy lines of steam pipe used at mines entails the adoption of special appliances to secure best results. Therefore, appliances calculated to ensure efficiency and economy in steam plants are of interest to our readers.

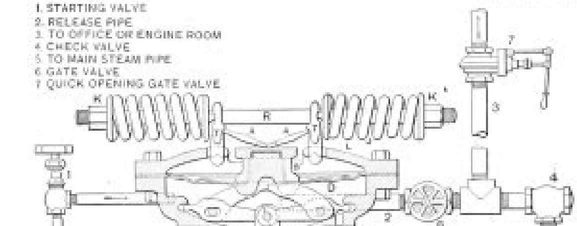


Fig. 1.—The Foster Automatic Safety Stop Valve.

Some time ago our attention was called to an automatic safety stop valve in use at the Lykens Valley Coal Company's mines near Lykens, Pa. This valve, shown in sectional view in Fig. 1, was designed by the Foster Engineering Company, of Newark, N. J., to meet a condition existing at one of the Lykens Valley Coal Company's mines, and which exists at almost every large mine in the country.

The condition was a very long line of large steam pipe, from the boiler plant on the surface to the point of utilization in the mine. These pipes are liable to injury, in which case the steam from the boilers is apt to escape, seriously interfering with the ventilation and doing great damage before notice can be sent to close off the stop-valve at the boilers. The same contingency is liable to occur in water mains. The breaking of a fitting, bursting of a pipe, or other accident, would result in more or less serious damage.

The operation of the valve is entirely automatic, and is as follows: Referring to Fig. 1, *A* is the pipe leading from the boiler; *B* is the pipe leading to the point of delivery. The normal position of the main steam valve, *H*, is closed. To open this main steam valve, close the gate valve 6 and open the angle valve 1. This allows steam from the initial pipe, *A*, to enter the diaphragm chamber, *D*, which, acting on the diaphragm against the power of the spring, opens the main valve, *H*. When the pipe, *B*, is fully charged, the angle valve

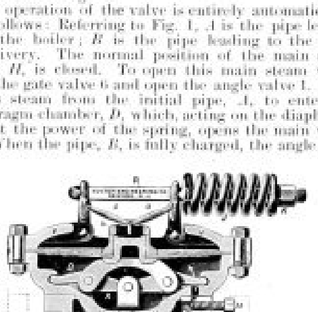


Fig. 2.—Foster Automatic Relief Valve.

1 is closed, and the gate valve 6 opened. The main steam valve, *H*, is then held open by the steam passing through the steam port, *E*, to the diaphragm chamber.

Pipe 5 is connected to the main steam line, *B*, at any desired point, or to a branch from the main line. In case of rupture of the pipe, *B*, or of any of its connections or fittings, the pressure in the diaphragm chamber is instantly relieved through the pipes 2 and 5, thereby allowing the spring to instantly close the main valve, *H*.

Pipe 3 is provided with an auxiliary lever gate valve, 7, which is properly located near the automatic stop valve. Cords or chains, running over pulleys, may lead from the end of the lever to any desired point or points. So that, in case of any accident requiring immediate stoppage of an engine, or pump, or to stop the flow of steam through the main line, it is only necessary to pull the cord or chain; this opens the valve 7, which relieves the pressure in the diaphragm chamber and instantly shuts off the steam. The check valve 4 is used to prevent back pressure from the main line *B*, from entering the diaphragm chamber and thereby making valve 7 inoperative. This device is attracting great attention from large steam users in all parts of the country. The United States Navy Department has recognized its great value by ordering two 5″ valves to be made throughout of government composition, for use on the battleship *Texas*.

Another application of a very similar principle forms the Foster Automatic Relief Valve for high and low pressure systems. Owing to the rapid introduction of high pressure boilers for mining work, which in many instances are to be used in connection with an older low pressure plant, some appliance is necessary to equalize the pressure from the two sets of boilers. The Relief Valve, located on a pipe connecting the high and low pressure systems, allows any excess of steam in the high pressure boilers to enter the low pressure system at any desired pressure. The action of this valve is as follows: The steam from the high pressure boilers acts on a diaphragm, similar to that in the Safety Stop Valve, which tends to open the valve against a spring, which can be adjusted to any point desired by the nuts *K*, Fig. 2. Fig. 2 shows a sectional view of an Automatic Relief Valve.

The Foster Pressure Regulator, see Fig. 4, applied as a pump governor ensures the automatic governance of the pump. When used as a pump governor it is applied to the steam pipe leading to the pump, and the speed and discharge is regulated by the nut *K*, Fig. 4.

This adjustment is so made that when the maximum discharge pressure is reached the pump will stop. This ensures immunity from danger of overflows if the water is pumped into a tank or reservoir. As a governor for mine pumps it ensures uniform speed for

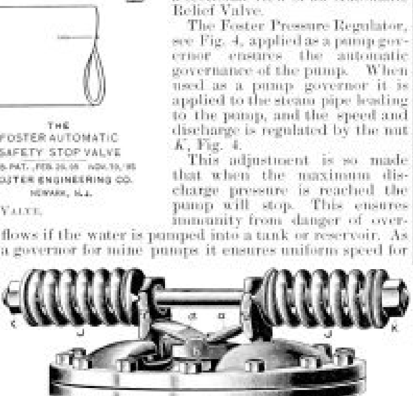


Fig. 3.—Large Size Foster Pressure Regulator, with Flanged Ends.

the pump. This is a great advantage, especially at mines where pumpmen are not on duty continuously.

The Mt. Lookout Coal Co., has in use at Mt. Lookout colliery one 3″ pump governor, and one 6″ reducing valve. The Forty Fort Coal Co., has in use at Forty Fort colliery one 4″ pump governor and two 2″ pump governors. Mr. J. L. Crawford, General Superintendent of the above two companies, speaks very highly of the appliances.

Fig. 4.—Foster Pressure Regulator.

In addition to the valves mentioned the Lykens Valley Coal Co., has in use one 8″ automatic safety stop valve, one 8″ reducing valve, one 4″ reducing valve and one 4″ pump governor.

The Susquehanna Coal Co., has in use at No. 1 shaft, Nanticoke, Pa., one 8″ relief valve capable of relieving pressure of from 100 to 125 pounds per square inch to a lower pressure of from 60 to 80 pounds per square inch. Full details of these specialties are given in the catalogues of the Foster Engineering Co., of Newark, N. J.

The Northwest Mining Association.

Below is the summary report of the meeting of the members of the Northwest Mining Association, held in Spokane, Wash., February 22nd, 1896: Meeting convened at 9.30 a. m., President G. B. Dennis in the chair, and about 100 officials of the association were present. After an address of welcome by Mayor H. N. Belt, the Secretary stated the objects of the meeting and the President outlined in an able address the plans, purposes and work done by the Association. He was followed by Judge W. P. Heyburn, of Osburn, Idaho, who spoke at considerable length on "Extra Lateral Rights" and presented the only true solution of this knotty problem yet offered to the miners of this section. In the afternoon John C. Davenport, of Nelson, B. C., addressed the convention on "Pioneer Mining." N. E. Lindsay, of Spokane, followed with the subject "How Can We Improve the Mining Industry Through This Organization." "Needed Legislation" was the subject of an address of A. F. Parker, of Grangeville, Idaho. William M. Pinkston, of Boundry City., Wash., spoke on "Good Roads." L. K. Armstrong followed with a brief address on "The Importance of Geological Surveys." S. G. Cosgrove, of Pomeroy, Wash., spoke at some length on general matters. A large number of telegrams and letters were read from absentees. General discussion followed, being participated in by A. P. Curry, C. H. Thompson and others, of Spokane; W. C. Butler, of Everett., Wash.; D. M. C. Gault, of Hillsboro, Oregon; Judge Heyburn, of Osburn, Idaho; H. C. Walters, of Libby, Mont.; F. A. Weber, of Lakeview, Idaho, and others. The meeting then adjourned after a brief session of detail work, and in the evening the citizens of Spokane tendered a banquet to the visitors which was participated in by about 125 persons.

The next annual meeting of the Association will occur October 3rd, next, and will be of three or four days' duration. The Association has Vice Presidents in all the districts of Montana, Idaho, Oregon, British Columbia and Washington, and the membership is increasing daily.

It is stated that the citizens of Butte, Mont., propose to invite the officials of the Association to convene in that city at an early date.

L. K. Armstrong, Secretary.

Personal.

Mr. Daniel Webster, for fifteen years associated with the Babcock & Wilcox Co., has resigned his position with that firm to take effect March 1st. Mr. Webster has for the last twelve years been the practical head of the manufacturing and construction department of the Babcock & Wilcox Co., and has made many strong friends among the large steam users and manufacturers throughout the United States, who will all be pleased to learn that his retirement from the Babcock & Wilcox Co. was for the purpose of accepting a better position with the manufacturers of the Cahall boiler, the Aultman & Taylor Machinery Co., Mansfield, O. Although the Cahall boiler has demonstrated its superiority as a steam generator, still there are many cases where lack of head room or prejudice prevents the adopting of anything but a horizontal water tube boiler. They have, therefore, decided to immediately engage in the manufacture of water tube boilers of the Babcock and Wilcox type, and Mr. Webster will have entire charge of this department. Aultman & Taylor expect to be ready to begin delivering the B. & W. type of water tube boiler by June 1st. H. E. Collins & Co., of the Bank of Commerce Building, Pittsburg, Pa., general sales agents for the Cahall boiler, will act in the same capacity for the B. & W. type.

Repair Time.

The approach of settled weather brings with it what is known to all mine owners as "Repair Time," and as the repairs about all buildings include painting, we are reminded that it is advisable in this regard as well as in every other, to get the most value for the investment. Therefore, we would suggest the use of an up-to-date paint, viz: that which will not only beautify the structure, but which will resist the action of the weather as well as the action of fire. Such a paint is made, as is well-known to most of our readers, by the Jamieson Fire-Resisting Paint Co. This company numbers among its patrons some of the leading mining companies; therefore it stands to reason that the users of these paints would not be experimenting with a new article.

For coating tin and other metallic surfaces, this company makes two kinds of special paints, viz: New York Graphite Paint, and Special Iron Paint.

A card to the Jamieson Fire-Resisting Paint Co., New York City, asking for particulars will receive prompt response.

Wanted—Second-Hand Machinery.

Advertisements of second-hand machinery for sale are of frequent occurrence, but a large display advertisement of second-hand engines boilers and pumps *wanted*, such as the Scranton Supply and Machinery Co. publishes in this issue, is rather rare. The Scranton Supply and Machinery Co. is a very reliable and enterprising concern, and when they advertise for anything they *want* it.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondents should be in as simple language, and as free of technical terms and formula as possible, consistent with clear relation.

Questions on subjects not directly connected with mining will not be published.

A Geometrical Problem.

Editor Colliery Engineer and Metal Miner :

SIR :—Please answer through your columns, the following question : A tree 120 feet high stands on the bank of a river 100 feet in width. At what distance from the ground should the tree be cut so that in falling the top will just reach the opposite bank of the river?

J. S. P.,
Feb. 28, 1896. Reynoldsville, Pa.

Correction.

Editor Colliery Engineer and Metal Miner :

SIR :—In my answer to Assistant Superintendent, Nelsonville, Ohio, in February issue of your valuable journal, the formula to determine the size of the steam cylinder should have been $\frac{(H \times P - B) \times S}{E} = A$, instead of $\frac{H \times P + B \times S}{E} = A$.

Yours respectfully, YES 0'.

Ventilation.

Editor Colliery Engineer and Metal Miner :

SIR :—Will some of your able readers kindly answer the following : I have a fan 15 feet in diameter, with blades 3 ft. 9 in. long and 4 ft. wide, incased in spiral expanding casing, the casing expanding from 0 to 37 inches. There are two central inlets each 7 ft. 6 in. in diameter, and the outlet is 4' 2'' × 6'. Now under ordinary conditions, with a water gauge of ¾ of an inch, and an angular velocity of 105 revolutions per minute, what quantity of air will be produced? What per cent. of the efficiency of the fan is due to the expanding casing? And at what speed will this fan cease to throw any air? I would like to have Mr. J. T. Beard of Ottumwa, Iowa, answer the above if he will kindly do so. Yours respectfully,

CARBON, Oskaloosa, Iowa.

A Fan Problem.

Editor Colliery Engineer and Metal Miner :

SIR :—Referring to the question put by your correspondent, James Hann, in the February issue of your journal, as to why there should be an increased quantity of air with the same water gauge, and the same tip speed: According to the understood theories of mechanical ventilation there can be only one explanation, and that is that there has been an enlargement of the air passages—that in fact, the new fan has been working on an enlarged equivalent orifice.

The equivalent orifice of the mine worked upon by the old fan $= \frac{.388 \times 43}{\sqrt{.4}} = 26.38$ square feet, whereas, the new fan is working on an orifice of $\frac{.388 \times 60}{\sqrt{.4}} = 36.81$ square feet.

The increased quantity on the same mine should have resulted in a higher water gauge, which with the larger quantity should have been $\frac{60^2 \times .4}{43^2} = .78$ inch.

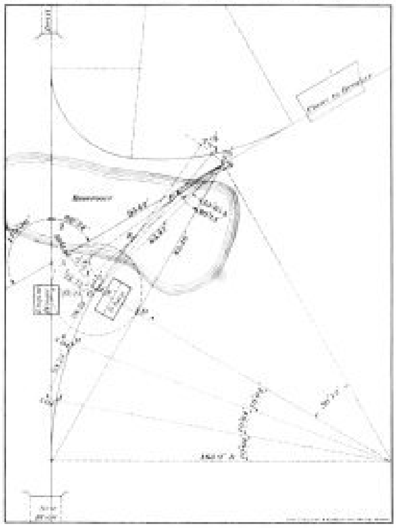
The manometrical efficiency of both old and new fan in this case, is, in the opinion of the writer, the lowest on record. (See a tabular statement of mechanical work performed by a number of fans at pages 160 to 163 in *The Practice and Science of Mining Engineering*. The circumferential speed of the fans referred to by Mr. Hann, running at 105 revolution per minute $= \frac{105 \times 12 \times 3.1416}{60} = 66$ feet per second, therefore, the theoretical water gauge is equal to $66^2 \times .000458 = 1.99$ inches ; hence, the manometrical efficiency is only $\frac{.4}{1.99} = .20$, which is so low that some explanation should be given of it.

Shafto House, Yours etc.,
Chester-le-Street, England. W. FAIRLEY.
Feb. 25, 1896.

Plan for Laying Out a Curve.

Editor Colliery Engineer and Metal Miner :

SIR :—As your valuable paper has been much help to me I contribute the enclosed sketch and show how I worked out a curve that may be of benefit to some of your many readers. I was called on to lay out a curve ; not having my plotting instruments with me I thought I would have to return to the office to work it out, but the superintendent was very anxious to get the stakes set at once, so that work could be commenced, therefore I set to work and staked it off as per the enclosed sketch that I made afterward. To tell the truth I was a little puzzled at first, but I found that I could get the intersection angle *I* 60° 24', and as I had to just miss the shop with the line, I could get the point *C* 25.75' or the intersection desired. To locate the curve, I divided the curve in 6 equal chords, so that the middle two would also intersect at the point *C*. Then I could locate my points of curves any place between 90 and 100 ft. from *A*, which gave me conditions that easily allowed the laying out of the curve as follows : The *I* angle being 60° 24', $180 - 60° 24' = 119° 36'$, $\frac{119° 36'}{2} = 59° 48'$, angle at *A*. The distance *A C* 25.75' represents the hypothenuse of a right angled triangle the base of which is the radius of a circle tangent to the two lines of intersection, that is, $A C - \text{Sin } 59° 48' \times 25.75' = 22.25$ ft. Then, $25.75 + 22.25 = 48'$, which is the central ordinate of the curve



chord desired, that will pass through *C* and fit to the intersected lines at an apex distance *A B* in the right angled triangles thus formed. $A B = \frac{A D}{\text{Sin } B}$. Now Sin $B = \frac{1}{2} I$ angle, or $\frac{60° 24'}{2} = 30° 12'$, then $\frac{48}{.503020} = 95.42' = A B$. In same triangle $D B = A B \times \text{Sin } A = 95.42 \times (\text{Sin } 59° 48')\ .864278 = 82.46'$ or ½ the total chord of the curve.

Then, $C B = \frac{D B}{\text{Cosine } b}$, angle $b = \frac{1}{2} B$ or $\frac{1}{4} I = \frac{60° 24'}{4} = 15° 6'$. We have, $\frac{82.46}{.965472} = 85.47$ ft. $= C B$. Now, having all the distances desired, I set instrument at *C*, sight to *B*, turn left 5° 2' and from *C* with radius of 85.47' set stake 1, turn left 5° 2' again and with same radius set stake 2. Then move instrument to *B*, sight to stake *C*, turn right 5° 2' radius 85.47'. Again, set stake 1' then 2', by same method. To check work, distance stake 1' to 2' is found to be 7.416' or ⅓ radius of the tangent circle around *C*. Then strings stretched from *C* to stake 2, from *B* to stake 1', intersect at point *E* on curve, and point *F* is found by the intersection of strings *C* to stake 1 and *B* to stake 2'. Then, by placing *C* and *B* to grade and locating at *C* 1' and 2' at same height as *C*, and at *B* locating 1 and 2 same height as *B* the grade of rail at *E* and *F* will also be located. Where a fill is to be made this method will be found to be very convenient. The other half of curve may be staked out as per article in October number of your paper. As indicated by the drawing, I am not sure that this method is new, but I have never found it in print. It being so convenient I submit it for what it may be worth and if it helps some other of your many readers I am well paid for the trouble. Yours, etc.,

S. W. DOUGLASS, Ashland, Pa.

Ventilation.

Editor Colliery Engineer and Metal Miner :

SIR :—Will you please insert the following in reply to "P. C.," Dominion No. 1, Nova Scotia :

1. Two shafts, 6 ft. by 6 ft., each 1,000 ft. deep, pass 45,000 cu. ft. of air per minute. How much must they be enlarged to reduce the power required one-half?

If the power is reduced by one-half, it will be as 2 : 1. Quantity varies as cube root of power ; therefore, $\sqrt[3]{2} : \sqrt[3]{1} :: 45,000 : 36,000$ cu. ft., the quantity that would pass with one-half the power, the shafts remaining as given. But the question calls for the same quantity, or 45,000 cu. ft. Now, if 36,000 cu. ft. passes in place 6 × 6, what must be the size of airway to pass 45,000 cu. ft., powers remaining the same?

$$\frac{45,000 \times (6 \times 6)}{36,000} = \frac{5 \times 36}{4} = 45 \text{ sq. ft.}$$

$$\sqrt{45} = 6.708 \times 4 = 26.832 \text{ ft. perimeter.}$$

$$\sqrt{36} = 6 \times 4 = 24 \text{ ft. perimeter.}$$

$$\frac{26.832}{24} = 1.118, \text{ relative perimeter.}$$

Divide the sum of square root and cube root of relative perimeters by 2 and divide the result into the area obtained by proportion above, for area of pressure remains the same. In this case,

$$\frac{\sqrt{1.118} + \sqrt[3]{1.118}}{2} \times 45 = 47.1375 \text{ sq. ft.}$$

$$\sqrt{47.1375} = 6.87 \text{ feet square.}$$

2. In a certain mine there are 10,500 cu. ft. of air per minute passing in an airway 5 ft. by 6 ft. and 2 miles long. Work was continued until the airway was 2½ miles in length, when a creep came on, which reduced the airway in area for 1 mile to 15 feet, or 5 ft. by 3 ft., and for a further distance of ½ mile to an area of 10 ft., or 4 ft. by 2½ ft. What quantity of air should then pass, the power remaining the same?

$$2 \text{ miles} = 2 \times 5,280 = 10,560 \text{ ft.}$$

$$2\tfrac{1}{2} \text{ miles} = 2\tfrac{1}{2} \times 5,280 = 13,200 \text{ ft.}$$

Pressure and power remaining the same, the quantity varies as the square root of the length of the airway, area being same in both cases.

Therefore, $\sqrt{13,200} : 10,500 :: \sqrt{10,560} : (\ )$
$= 114.9 : 10,500 :: 102.7 : 9,385$ cu. ft.

We would have 9,385 cu. ft. passing in the 2½ mile airway before the depression took place. Now, the question becomes : If 9,385 cu. ft. passes in an airway 13,200 ft. long, 5 × 6, what quantity will pass in an airway of the following dimensions : 5,280 ft., 5 × 3 ; 2,640 ft., 4 × 2½ ; 5,280 ft., 5 × 6, powers remaining the same?

Proceed to find the units of work in each airway and section of airway with 9,385 cu. ft. of air passing, using the formula

$$p = \frac{k s v^2}{a}.$$

13,200 ft. airway, $p = \frac{.0000001 \times 290,400 \times 313^2}{30} = 9.5$ lbs.

5,280 ft. " $p = \frac{.0000001 \times 84,480 \times 626^2}{15} = 22.1$ "

2,640 ft. " $p = \frac{.0000001 \times 34,320 \times 938^2}{10} = 30.3$ "

5,280 ft. " $p = \frac{.0000001 \times 116,160 \times 313^2}{30} = 3.8$ "

Units of work $= p \times q =$ 9.5 × 9,385 = 89,157 units.
22.1 × 9,385 = 207,408 "
30.3 × 9,385 = 284,365 "
3.8 × 9,385 = 35,663 "
527,436 "

Now, quantity varies as cube root of units or power. Therefore,

$$\sqrt[3]{527,436} : \sqrt[3]{89,157} :: 9,385 : 5,102 \text{ cu. ft.}$$

Yours, etc.,
A. MOLECULE,
Victoria Mines, C. B., N. S.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue or three months subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for April.

QUES. 217. During the course of some experiments we have been making with a Mueseler lamp, with the view of perfecting our new safety lamp, we have found that when we make the top diameter of the conical funnel five-sixteenths of an inch, the lamp flame dies out when the entering air contains about 7 per cent. of marsh gas, and when we make the top diameter of the funnel five-eighths of an inch the lamp is not safe in an explosive mixture. We will therefore feel obliged if you will explain to us how it is that the lamp is safe with the small diameter and absolutely unsafe with the large one.

QUES. 218.—We are ventilating a mine with a furnace, and the quantity of fresh air entering per minute is 100,000 cubic feet. The furnace consumes 1.5 long tons of coals per hour. The composition of the coal is 78 per cent. fixed carbon, 10 per cent. volatile hydro-carbons and 12 per cent. ash. The volatile hydro-carbons may be taken at the average composition of $C_2 H_4$. Now, we wish to know what will be the volume measure per minute of the air and gases ascending from the furnace in the upcast shaft, when the temperature of the descending air is 60° F. and that of the ascending air 200° F.

QUES. 219.—We have a seam of bituminous coal 4.5 feet thick; it is lying nearly level; The bottom rock is hard and strong, but we have a following of 4 feet of slate that we cannot keep up. The shafts when sunk will be 800 feet deep, and we will therefore be obliged to you if you will explain with a sketch how we should work this seam so as to obtain the highest possible percentage of large coal, and yet be able to keep the roads and rooms in safe condition without the loss of much timber.

QUES. 220.—We have a ventilating fan exhausting from our mine 150,000 cubic feet of air per minute with a water gauge of .8 inch, and we wish to set up another and larger fan to increase the ventilation to 250,000 cubic feet. We will therefore be obliged to you if you will furnish us with the following values for the new fan, so that we may secure the best results:

First—The diameter of the fan.
Second—The breadth or length cylinderwise.
Third—The number of revolutions.
Fourth—The radial length of the blades.
Fifth—The area of the orifice of entry.
Sixth—The area of the throat.
Seventh—The area of the orifice of discharge.
Eighth—The effective horse power of the fan, taking *T* instead of *M* for the pressure per square foot.

QUES. 221.—In looking over a topographical map and the text of the notes of the survey, I observed three hills, and their apices were lettered *S*, *T* and *U*. The apices of *S* and *T* were shown to lie in a line that was bearing North 63° East from S, and the apex of *U* was shown to bear South 27° East from that of *T*. The mean angle of elevation of the southwest slope of *S*, measured from the foot of the slope at *A*, was 32° 45′, and the mean angle of elevation measured at *B* at the foot of the slope at the southeast side of *U* was 19° 56′. The vertical heights of the hills were: *S*, 784 feet; *T*, 472 feet, and *U*, 320 feet. The angle of elevation of the apex of *S*, measured from the level of the apex of *T*, was 6° 25′, and the angle of depression of the apex of *U*, measured from the level of the apex of *T*, was 4° 45′. I will be pleased to receive from you a sketch with the necessary explanation, showing the process by which you have found the distance in a straight line from *A*, at the foot of the southwest slope of *S*, to *B*, at the foot of the southeast slope of *U*.

QUES. 222.—In a mine shaft in course of being sunk an iron kettle full of water was hoisted from the bottom at a mean velocity of 6 feet per second. The kettle was cylindrical in shape and 3.5 feet in diameter and 3.5 feet deep, and by some unknown cause a round hole had been cut through the bottom, and it had a mean diameter of 3 inches. The result was that the kettle left the sump in the shaft bottom full of water and arrived at the top of the shaft empty, and by coincidence the discharge of water just ceased at the moment the kettle reached the surface. Now, I will be obliged if you will deduce for me, out of these facts, the depth to which the sinking has advanced.

Answers to Questions which Appeared in the February Issue, and for which Prizes Have Been Awarded.

QUES. 205.—As we are determined to leave no stone unturned until we secure all the necessary facts for constructing a new lamp on correct principles, will you tell us how much the illuminating power of the light of a safety lamp is reduced in its passage through the glass cylinder that surrounds it? Base your calculations on the following thicknesses: 1/16 inch, 1/8 inch, 1/4 inch.

ANS.—The lost and disposable light of the different glasses will be as follows:

Thickness of Glasses.	Loss of Light.	Disposable Light.
1/16 inch.	70 per cent.	30 per cent.
1/8 inch.	60 " "	40 " "
1/4 inch.	50 " "	50 " "

THOS. S. ASKEY,
Dysart, P. O., Cambria Co., Pa.
Second Prize, HUGH CAIRNS,
Elco, Washington Co. Pa.

QUES. 206.—We are constructing boilers for raising steam by the burning of bituminous coal in the State of Tennessee, and as we are going to manufacture fine white paper we wish to consume all the volatile matter and soot given off by the burning coal; will you, therefore tell us how this objectionable matter could be consumed, and thus increase our available energy instead of wasting it by allowing this combustible matter to escape? We do not want any plans or sections for the construction of a furnace, as we can do them ourselves when you supply us with the principle required for the burning of this waste carbon.

ANS.—For complete combustion and the prevention of smoke, no more than a sufficient supply of air must be admitted. Now the needful supply cannot all enter up through the grating and the fire, even with the help of a steam jet or forced draught, because the air loses much of its active oxygen in passing through the incandescent cinders. The admission, then, of the oxygen to burn the volatile matter of the coal must be over the fire, and provision must be made to maintain the right temperature of the mixed air and gases for the combustion of the carbon particles of the smoke. The provisions required for the complete combustion of the smoke may be noticed under three heads.

First—For the admission of the right supply of air, I use a stoke door hung by top hinges and made to turn in a box case, so that when the door is partly opened its sides are always close to the sides of the case, and thus the side entry of air is prevented, while provision has been made for the door to open inward under the control of a rack, and by this means only admit a thin sheet of air under the bottom edge of the door. The entering air is therefore projected in a sheet immediately onto the fire.

Second—Admit the correct supply of air; for too much air cools the gases and the carbon and prevents their combustion, and too little air directly prevents complete combustion, and, therefore, carbonic oxide CO is not burned into CO_2 with the consequent waste. Again, the necessary supply of air must not take place too early or too late, and to secure the best results I provide a peep hole for an attendant to observe the flame and admit the supply of air required from time to time.

Third—To secure the required temperature for the burning of the carbon particles and the other volatile matter, I line the sides and front of the fire box with fire brick, and make the bridge wall a fire brick trellis that is of sufficient area for the free passage of the burnt gases, and presents such a multiplied incandescent surface to the air and gases that complete combustion must ensue. The principles here explained can be applied to any style of boiler.

G. S. RICE,
Second Prize, 119 South Market Street,
WM. HIBBS, Scio, Ohio. Ottumwa, Ia.

QUES. 207.—Our bituminous coal is of excellent caking quality, but the demand for coke is small and the price is low; the vein is tender and we make 40 per cent. of slack. We have a good market for household coals and I have recommended the manager of the company to make the slack into briquettes, and he replied, "If you can furnish me with a successful plan for doing so, I will advise the company to raise your wages $50 a month." This being so, I will be obliged to you if you will assist me by supplying the following facts:

First—Which of the following materials will make, from a physical point of view, the best binder for the briquettes: Clay, hydraulic lime, Portland cement, asphaltum, pitch?

Second—Which binder gives the best appearance to the briquettes?

Third—Which binder is the best for its price and commercial advantages?

Fourth—What are the best forms and dimensions to give the briquettes?

Fifth—How are the briquettes made, and where are any briquette presses with their mixing appliances to be seen in the United States?

ANS.—Pitch makes the best binder, being sticky when heated and it will harden when dry and will also burn with the coal, but has the objection that it makes a great deal of smoke during combustion. It is now used almost entirely.

Clay would be the cheapest binder, but is objectionable from the fact that it represents just so much ash and dead weight in the briquettes.

The best shape for briquettes destined for domestic purposes is ovoidal and about the size of a goose egg; for steam purposes brick shapes of all sizes are employed.

In the manufacture of briquettes the coal is first ground to a uniform size and dried in a small furnace, one of which is described as having a rotating bottom and fitted with stirrers to mix the coal; the coal is then mixed with from 5 to 7 per cent. of partly melted pitch which is thoroughly incorporated by a pug-mill, disintegrator or screw which delivers it to the briquette machine; this machine is composed essentially of a mold plate and dies which compress the coal on several sides at once or sometimes a machine consisting of a long tube with a ram, is employed, the ram compressing and forcing out the paste which is cut up into sections of the proper length by a knife or wire, as in brick-making; the briquettes are then cooled.

CHAS. ED. BOURON,
Tracy City, Tenn.
Second Prize, HUGH CAMPBELL,
Gowrie Mines, Cape Breton, N. S.

QUES. 208.—Where is asphaltum mined on the continents of North or South America? What are the characteristics of its physical and geological environment; that is to say, is it found in veins or in solutions in oils? Has it any connection with salt lakes? Was its origin vital or chemical? And further, to what general use is it applied? And what is its chemical composition?

ANS.—Asphaltum is found in North America, as far north as the Ohio river, it is found in Breckinridge Co., Ky. Asphaltum bitumen is a smooth brittle substance which breaks with a polish. When pure it burns without leaving any ashes; the products of combustion emit a strong smell of pitch; it is found in a liquid state on the surface of the Dead Sea; it is found in many parts of Asia, Europe and South America. Our greatest source of asphaltum is from the Island of Trinidad, where there is a lake 4,000 feet long and 2,400 feet wide, containing 114 acres. Trinidad is part of the mainland, its flora warrants that, so I considered this South America. The lake is owned by the Island of Trinidad and is under a lease of 45 years to the Trinidad Asphaltum Co. This company pays $1.60 per ton royalty, and the profit to the government is $150,000 per year. The lake is steadily falling from year to year, but the supply will not give out in our generation. Test holes have been put down in the lake to a depth of 160 feet and did not find bottom. Assuming that it is no deeper and none added, the supply will last 300 years.

The consistency of the lake is about the same as cheese. This asphaltum comes from deep sources and no doubt had its origin from vegetable matter. Carbon and hydrogen enter into its composition.

In olden times asphaltum was used for embalming the dead. The solid asphaltum is employed in Persia and Arabia for ships instead of pitch. A composition of asphaltum, lamp black and turpentine makes a durable black paint. It is used for roofing purposes, covering bridges, etc. It is very durable in air and not penetrable by water. A composition of asphaltum and gravel is extensively used for paving streets.

A. W. EVANS,
Petros, Morgan Co., Tenn.
Second Prize, HERBERT A. WILCOX, Aspen, Colorado.

QUES. 209.—By closely watching four men at work, namely, *a*, *b*, *c* and *d*, we found that *a* and *b* could fill 65 tons of coal in 5 days; *a* and *c* could fill 84 tons in 7 days; *a* and *d* could fill 44 tons in 4 days; *b* and *c* could fill 135 tons in 9 days; *b* and *d* could fill 42 tons in 3 days; and that *c* and *d* could fill 78 tons in 6 days. Will you tell us, then, how many tons of coal each of the men, that is, *a*, *b*, *c* or *d*, separately can fill in one day?

ANS.—First find the weights the pairs would fill in one day, as

$$a \text{ and } b = \frac{65}{5} = 13 \text{ tons.}$$
$$a \text{ and } c = \frac{84}{7} = 12 \text{ tons.}$$
$$a \text{ and } d = \frac{44}{4} = 11 \text{ tons.}$$
$$b \text{ and } c = \frac{135}{9} = 15 \text{ tons.}$$
$$b \text{ and } d = \frac{42}{3} = 14 \text{ tons.}$$
$$c \text{ and } d = \frac{78}{6} = 13 \text{ tons.}$$

The tons filled in one day by each man can be found as follows:

$$a = \left[\frac{(a \text{ and } b) + (a \text{ and } c) - (b \text{ and } c)}{2}\right] \text{ or}$$
$$a = \frac{(13 + 12 - 15)}{2} = 5 \text{ tons.}$$
$$b = \left[\frac{(a \text{ and } b) + (b \text{ and } c) - (a \text{ and } c)}{2}\right] \text{ or}$$
$$b = \frac{(13 + 15 - 12)}{2} = 8 \text{ tons.}$$
$$c = \left[\frac{(a \text{ and } c) + (b \text{ and } c) - (a \text{ and } b)}{2}\right] \text{ or}$$
$$c = \frac{(12 + 15 - 13)}{2} = 7 \text{ tons.}$$
$$d = \left[\frac{(a \text{ and } d) + (b \text{ and } d) - (a \text{ and } b)}{2}\right] \text{ or}$$
$$d = \frac{(11 + 14 - 13)}{2} = 6 \text{ tons.}$$

JAMES ABERCROMBIE,
Monongah, Marion Co., West Va.
Second Prize, EVAN COCKBURN,
Page Bank, Spennymore, Durham, England.

QUES. 210.—A shaft for a coal mine has been sunk to a depth of 1,000 feet, and at a depth of 898 feet we tapped a feeder of water that shed 500 gallons per minute, and after an accident to the engine that caused the stoppage of the pumps, the water rose to a height in the shaft of 700 feet. The sectional area of the shaft is equal to 140 square feet, and I will be obliged if you will make a diagram to scale, showing by the ordinates the velocities of the inflowing water at eight equally distant points in the elevation, and while you are busy, please calculate for me the time required for the feeder to fill the shaft to a height of 700 feet.

ANS.—The head of the feeder must equal the height the water rises in the shaft, since water seeks its level. We use the well known formula:

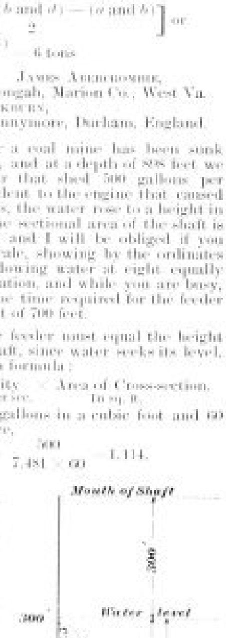
Discharge in cu. ft. per sec. = Velocity in ft. per sec. × Area of Cross-section in sq. ft.

There are 7.481 U. S. gallons in a cubic foot and 60 seconds in a minute, hence,

$$\text{Discharge in cubic feet} = \frac{500}{7.481 \times 60} = 1.114.$$

Velocity in ft. per sec. = $\sqrt{2gh} = \sqrt{2 \times 32.2 \times 598} = 196.2$. Area of Cross-section of feeder = $\frac{\text{Discharge}}{\text{Velocity}} = \frac{1.114}{196.2} = .0056763$ sq. ft.

If the water shot straight up, the time required for it to rise 598 feet above the feeder $= \frac{\text{Velocity}}{g} = \frac{196.2}{32.2} = 6.095$ seconds. But the time it fills 102 feet below the feeder is at the rate of the velocity at the discharge $= \frac{102}{196.2} = .52$ seconds. The time required to fill the entire shaft is proportional to the area of its cross-section $= \frac{140}{.0056763}(.52 + 6.095 = 6.615)$ seconds, which reduced to days =



$$\frac{140 \times 6.615}{.0056763 \times 60 \times 60 \times 24} = 1.9 \text{ days.}$$

Observe, the curve whose ordinates are represented by the velocities is a parabola.

H. C. GUERRANT, Pilot, Va.
Second Prize, H. K. MOBERLY, West Newton, Pa.

Iron and Steel Roofing, Steel Buildings, Etc.

With this number of THE COLLIERY ENGINEER AND METAL MINER the Garry Iron and Steel Roofing Co., of Cleveland, O., begin the publication of an advertisement calling attention to their specialties of manufacture, iron and steel roofing, corrugated and plain metal siding, etc.

In addition to being manufacturers of such goods the Garry Co. also design and erect complete steel-framed structures for all purposes, in the mining trade soliciting the patronage of concerns who propose to make improvements in surface works, such as breaker structures, tipples, shaft-head frames, engine, boiler and fan houses, etc. They also make paints for such structures to meet the requirements of service.

This company issues a catalogue known as "No. 111," in which there is a great deal of useful information pertaining to roofing and architectural sheet metal work generally, which book they will gladly send to all mine operators and superintendents on application therefor.

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AND

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CORRECTION.

IN OUR editorial on "The Mineral Resources of Various Nations," in our March issue, we stated that "the output of *metallic copper* from the British mines in 1890 was 236,000 tons, and in 1894 it had fallen to 5,504 tons." This should have been stated as "*copper ore and copper precipitate*," as given in Prof. C. Le Neve Foster's Report to the British Government.

MINE FATALITIES.

AS the reports of the various inspectors of mines for 1895 are made public, our attention is again forcibly drawn to the enormous percentage of mine fatalities and serious injuries due to falls of roof or coal. It is not only in America that this is the case. The same relative percentages occur in European mining countries. Fully 60 % of all the deaths and serious injuries in coal mines are due to falls of roof or coal. "Whose fault is this?" "What is the remedy?" are two questions that are pertinent to every mine owner, mine official and miner.

The fault directly lies with the miner, and the miner at fault is almost invariably the victim. Neglect to properly support or pull down dangerous pieces of coal or rock, until another wagon is loaded, until another hole is drilled, or until some other piece of work that could be delayed with safety is accomplished, has resulted in more fatal accidents in coal mines than all explosions of gas, accidents from cars, explosions of powder and breaking of hoisting ropes combined. It is only when the record of fatalities for a year or a term of years is taken that the awful consequences of recklessness on the part of miners, in "deaths from falls of roof and coal," can be appreciated. As a rule such accidents only kill or maim one or two men at a time, and the public, made callous to *small* accidents, keeps no note of their frequency. An explosion of gas or coal dust in which a large number of men are killed at once excites the horror of whole nations, and the breaking of a hoisting rope by which from six to ten men may be killed does not pass unnoticed. But a three or four line item in a daily paper stating that "John Smith, a miner at Blank colliery, near Blanktown, was killed by a fall of coal this morning" is forgotten almost as soon as read.

That the miners themselves do not attach the importance to such matters that they should, is evidenced by the fact that most miners, who would not think of opening a safety lamp in a prohibited part of a mine, will not hesitate to work under a piece of coal or rock which they know to be loose, but which they *think* will "hold up" until another hole is drilled, another wagon loaded, or another rail laid. They will not hesitate to return to the working face immediately after firing a shot, notwithstanding the workings are full of smoke, and common sense and experience teaches them that every shot disturbs and loosens more or less coal and rock above their heads. As props are furnished free of expense to miners, and they know the danger of neglecting to set a prop or to pull down dangerous pieces, it is but just to directly blame the miner for the accident that either kills or maims him.

Now for the remedy. In touching on this portion of the subject it will be seen that the mine foreman or superintendent is *indirectly* responsible for many accidents due to falls of coal and rock.

Naturally it is impossible for a mine foreman to stand over every miner with a club and force him to look after his own safety. But there is another way. It is by the use of strict discipline and the enforcement of rational rules. If a mine foreman would instantly discharge every man he caught working under a dangerous piece of coal or rock, and continue doing so for a couple of months, he would soon give his employes salutary object lessons that would result in a marked diminution of accidents from this cause. While a mine foreman can not keep his eyes on the miners at all times, he does and can come on them at unexpected times. If when he does this he finds them neglecting their own safety, he should enforce the rule with greatest rigor and accept no excuse. A few discharges will be enough. His men will soon learn that the boss means business, and that if they disobey his orders by neglecting to set necessary props or pull down a loose piece of slate, they lose their jobs. This duty should be impressed on the foreman by the superintendent or owner, and the foreman should instruct his assistants, if he has any, to enforce the rule as rigidly as he does himself. To make the rule effective, there must be no appeal from the discharge given by the foreman. His discharge for a violation of the rule should be final. Such action may seem harsh, but in reality it is not. It is calculated to work for the good of the miner. The mine foreman or superintendent who does not apply some such rule as this is not doing his duty, and he is in a measure responsible for the accidents.

STATE GEOLOGICAL SURVEYS.

OUR remarks last month on the desirability of making State Geological Surveys of permanent value, and of keeping them up to date, by the employment of a permanent State Geologist, and a small corps of assistants, has met with considerable favor in Pennsylvania. However, there is some opposition to such a plan from influential men, who appreciate the value of such reports as would naturally be issued. This opposition is due to a misunderstanding regarding the operations of the Second Geological Survey. It is claimed that the Second Geological Survey discriminated in favor of the anthracite coal fields, and against the bituminous fields of Western Pennsylvania. This statement is based on the fact that more reports were issued bearing on the anthracite fields than on the bituminous fields, which cover a far greater area.

Let us calmly look into this charge and see *why* such was the case. In the first place, the large anthracite companies, and many of the individual operators had competent corps of mining engineers who had been for years, and were at the time of the Geological Survey, actually making geological surveys. The cross-sections, maps and notes of these surveys were generously placed at the disposal of the State. The result was the State employees had ready made for them accurate and comprehensive surveys which needed only connections and intelligent compilations to make them available for reports. While some of the bituminous mining companies were equally generous to the officers of the survey, they did not have the elaborate system of surveys in force that were peculiar to the anthracite regions, and therefore a certain amount of work put on a bituminous field by the State did not supply one-fourth as much information as the same amount of work put on an anthracite field.

Again, the peculiar geological features of the anthracite fields made necessary more detailed reports than would have been required by the bituminous fields, even if the bituminous mine owners had been able to give the officers of the survey the most comprehensive maps, etc. In fact it was the peculiar geological features of the Schuylkill and Lehigh regions that made necessary geological surveys on the part of the mining companies.

It can be stated as an absolute fact that the mine owners and mine officials of the anthracite regions furnished fully seventy-five per cent. of the information in the reports and atlases pertaining to those regions. This statement is not intended as a reflection on the officers of the survey. They were bright, intelligent men, and appreciated the value of the surveys, etc., so freely donated to them. In fact, most of the officers of the Geological Survey had previously helped make some of the surveys donated.

The work of a State Geologist and his assistants, in the future, would be more in the line of completing the reports of other sections of the State than in doing any work in the anthracite regions. The anthracite regions are well surveyed and the geological features are well known to all interested. As much cannot be said of all our bituminous fields. Besides, there are other mineral deposits in Pennsylvania besides coal, that need attention. We therefore repeat that a permanent State Geologist for Pennsylvania will place a permanent value on the work of the Second Geological Survey, and will make forever unnecessary a complete resurvey of the State. Other States of the Union, now having geological surveys in operation, will be greatly benefitted by providing for a continuance of their surveys on a rational scale after the general and more expensive work has been done.

MINE EQUIPMENT CATALOGUES.

WE DESIRE to impress upon mine managers and superintendents the importance to them of manufacturers' catalogues in all lines of mine equipment.

Every enterprising maker of mining goods, as of others, is constantly making changes and improvements suggested by his experience and observation; and well-prepared trade catalogues secured at intervals form an excellent means of keeping informed on what such manufacturers are doing. And besides the catalogue feature proper, not a few concerns put out publications for gratuitous distribution to men interested as users of their goods, which are of decided merit and convenience as books of reference.

It involves no great expense or trouble on the part of any mining company to make suitable receptacles for filing and recording such publications and once done and its frequent replenishment properly attended to, it forms a veritable encyclopaedia of mining appliances. This, in case of accident or emergency might prove invaluable.

Many manufacturers, with good reason, are chary about sending out expensive catalogues until asked for them, as too often they go into waste-baskets unopened and unread, though they contain matter really valuable to the recipients. But these same manufacturers will without exception be more than glad to send their publications to any interested parties who will ask for such.

The advertising pages of THE COLLIERY ENGINEER AND

METAL MINER are a directory of leading makers of mine equipment, but from the nature of the case the advertisements cannot go into such detail as well-prepared catalogues. The advertisements point the direction in which to look for the best catalogues, and, we may say, for the best machinery.

In this connection we will suggest to makers of mining goods that in future editions of catalogues &c., they adopt what has come to be known as "standard" sizes for such publications. We recently saw in a mining engineer's office just such a collection of catalogues as we have herein suggested for mine managers generally to keep up, and while very valuable for reference, the variety in sizes and style of bindings used was enough to distract most men to whom order and convenience is some objective. Too often a catalogue, the real value of which is recognized by the recipient, is allowed to go to waste simply because its shape or manner of binding makes its preservation almost an impossibility. Good paper and typography are appreciated by all, but we fear some of these latter-day "works of art" in trade catalogues are not, and the result falls heavily on the men who pay the printer's bills.

In closing we desire to again emphasize the need of better appreciation by mine managers of catalogues and other trade publications, and, on the part of manufacturers, more careful regard for the convenience and patience of mining men when sending out printed matter.

LIFE OF THE WYOMING ANTHRACITE COAL FIELDS.

THE series of articles on anthracite coal, prepared by Mr. Wm. Griffith, E. M., of this city, for *The Bond Record*, of New York City, are not only very interesting, but of great value, especially to those financially interested in anthracite mining or anthracite stocks. His first instalment, which appeared in the February number, was of an historical nature. His second installment, for the March issue of *The Bond Record* is primarily statistical, but at the same time is accompanied by text that bears on and makes clear the statistics. The most important portion of the article so far published, from an economical standpoint, is the tabulated estimate showing the approximate future supply of coal tonnage from lands owned or controlled by the various railroads having access to the Wyoming region.

In analyzing this table it is necessary to have an understanding of the term "Foot Acres" used by Mr. Griffith. This term means that there are so many acres of coal one foot thick. In other words, 100 acres of land containing a 4 ft. seam of coal, would mean 400 ft. acres. In his estimates Mr. Griffith did not include any coal under 4 ft. in thickness. An analysis of Mr. Griffith's comprehensive table furnishes the following summary:

RAILROADS.	Original Contents of Land Owned or Controlled in Foot-Acres.	Contents of Land Remaining Unmined Jan. 1, 1896, in Foot-Acres.	Unmined Tonnage On Jan. 1, 1896, at rate of 650 tons per Foot-Acre.	Tonnage 1895. (Estimated).	Duration of Supply Based on 1895 Shipments.
Delaware & Hudson Canal Co	330,445	178,188	115,822,200	4,517,845	26 years.
New York, Ontario & Western Railway	37,290	21,494	13,971,100	1,424,467	9 "
Erie Railroad	97,549	59,816	38,879,400	1,820,028	21 "
New York, Susquehanna & Western R.R.	83,095	41,370	26,890,500	1,492,244	18 "
Erie & Wyoming Valley Railroad	224,854	145,964	94,876,600	1,746,832	54 "
Delaware, Lacka. & Western Railroad	686,517	511,280	332,332,000	6,129,260	54 "
Lehigh Valley Railroad	372,562	276,000	179,400,000	5,116,495	35 "
Central Railroad of New Jersey	642,733	534,925	347,701,250	2,790,692	124 "
Pennsylvania Railroad	255,773	155,917	101,346,050	1,962,996	52 "
Individual lands as yet undeveloped and not controlled by any corporative interest	41,401	41,401	26,910,650		
Totals	2,746,396	1,966,355	1,278,130,750	24,031,679	52 years.

A Great Electrical Mining Plant.

When the Westinghouse Electric and Manufacturing Company installed an alternating current electrical power transmission plant at Telluride, Colorado, in 1891, the electrical world was very much interested in the operation, because it was the first plant of its kind that had ever been installed in this country. The apparatus had been ordered by the San Miguel Consolidated Gold Mining Company, a corporation owning a vast area of gold-mining territory in the Colorado mountains. Hitherto it had been commercially impracticable to operate these mines, because the excessive cost of fuel and power at an altitude of 3,000 feet above the sea level made it prohibitive. It was then that electric power was suggested, which promised to overcome the difficulty, especially since the company owned a waterfall in the San Miguel valley, which contained a sufficient amount of water power to operate all their mines, if it could be made available.

It was then that it was suggested to Mr. Nunn, the general manager of the company, to investigate the Tesla polyphase system of electrical power transmission. This was done with the result that a contract was entered into and the Westinghouse Electric and Manufacturing Company asked to install a 100 horse-power A. C. generator and a 100 horse-power motor, with the necessary switchboard appliances. The generator was connected with a Pelton water wheel and the current was carried for three miles up the mountains to the Gold King mine. The wonderful success of this undertaking was established from the first. The owners of the San Miguel company have become so thoroughly convinced of this fact that they recently contracted for an extensive increase in the electrical plant. The additional machines were ordered from the Westinghouse company some time ago, and they are now being installed.

These machines are two 800 horse-power, 500 volt quarter-phase generators running at 7,200 alternations. These generators will be direct connected to two Pelton water wheels, and two 30 horse-power multipolar generators will be operated as exciters. While this machinery will be installed in the central power house, the company will have a number of sub-stations at the different mines throughout their property. Among these stations will be distributed twelve 50 horse-power polyphase Tesla motors, fifteen 20 horse-power polyphase Tesla motors, twelve 100 K. W., 100-11,000 volts, 2-phase-3-phase step-up transformers; ten 50 K. W., 10,000-220 volts, ten 25 K. W., 10,000-220 volts, and sixteen 10 K. W., 10,000-220 volts, step-down transformers. The motors will be attached either by belt or direct connected to operate stamps, pans, hoists, crushers, elevators or pumps. It is expected that this installation will prove the most complete electrically equipped mining plant in the world. The Westinghouse company will also furnish all the necessary switchboard apparatus with the plant.

Death of Mr. Nat. W. Pratt.

It is with sincere regret that we announce the death of Mr. Nat. W. Pratt, president of the Babcock & Wilcox Co., which occurred on the 10th ult. at his residence in Brooklyn, N. Y.

Mr. Pratt was born in Baltimore in 1852. He was a descendant, on both his father's and mother's sides, of the early settlers of Plymouth county, Mass., both branches of the family having settled there in 1630. His mechanical tastes were inherited, his father, William Pratt, having been superintendent of the Burnside armories, in Providence, R. I., during the war of the Rebellion.

Mr. Pratt entered the employ of the firm of Babcock & Wilcox when quite a young man in 1870. His energy, engineering qualities and remarkable business qualifications soon won the confidence of his employers. In 1881 when the Babcock & Wilcox Co. was organized as a corporation, he was made treasurer and manager of the new company, retaining this position until the death of Mr. George H. Babcock, in 1893, when he was elected president.

Combining engineering knowledge and inventive genius with extraordinary business qualifications, to his efforts were largely due the wonderful success achieved by the Babcock & Wilcox boiler throughout the civilized world.

As an illustration of his versatility, we would simply mention that in 1884 he became consulting engineer to the Dynamite Gun Co. Under his designs and patents the first successful dynamite gun was built. It was with this gun, 8 inch calibre and 60 feet long, that the experiments in throwing aerial torpedoes were conducted at Fort Lafayette, N. Y.

Mr. Pratt leaves an aged father and mother and also a wife and three children. He was a member of the American Society of Mechanical Engineers, of the American Institute of Mining Engineers, of the American Naval Institute, and a member of the Engineers' Club of New York City. His early death in the prime of life is a loss not only to the Babcock & Wilcox Co., but to the mechanical world at large. By his extraordinary sagacity and sound business judgment the business that engrossed his life developed and grew from a very small beginning to the enormous and world wide business of the Babcock & Wilcox Co. This enormous business and the world wide reputation of the Babcock & Wilcox boiler form the best monument that he could leave behind him. Mr. Pratt was noted not only for his sound business judgment and remarkable energy but also for his generosity and kindness of heart. Even his business opponents admired him for his singular aggressiveness as applied to business, and he was universally loved and admired by all with whom he came in contact both in a social and a business way.

Maryland Coal Statistics.

We are in receipt of the reports of the Inspector of Mines for Alleghany and Garrett counties, Maryland, for the years ending Dec. 31, 1894, and Dec. 31, 1895.

The output of coal for the year 1894 was 3,101,982 tons. The number of men and boys employed in and about the mines was 4,147. During the year there were seven fatal accidents, three of which were caused by falls of roof coal, one by fall of rock, one by fall of earth, one by fall of breast coal, and one by cars. During the year there were 13 non-fatal accidents, the causes of which are not stated.

An analysis of these figures shows that there were 443,140 tons mined for each fatality and 238,614 tons mined for each non-fatal accident. There were 748 tons mined per each employe and 1.688 fatalities per each 1,000 employes.

During the year 1895 the output was 3,479,499.15 tons, an increase of 377,517.15 tons over the production of 1894. The number of men and boys employed was 3,921, a decrease of 226 as compared with the preceding year. During the year there were 9 fatal accidents, one only of which was due to fall of roof coal. Five deaths were due to accidents with cars, etc.; one from injuries received from a circular saw; one from "injuries received in mine," and one from a natural sudden death. The number of non-fatal accidents was 13, the same as in the preceding year. Six of these accidents were caused by falls of breast coal and two by falls of top coal. The other five were caused by cars.

There were 386,611 tons of coal mined per fatality, and 267,654 tons per each non-fatal accident. There were 887.4 tons mined per employe, and 2.295 fatalities per 1,000 employes.

Montana Mining Statistics.

Captain C. S. Shoemaker, State Mine Inspector of Montana, has completed his report for the year 1895, but owing to lack of available funds, the report will not be printed until next year. The following extracts from the report we clip from the *Western Mining World* of Butte, Montana:

"It is gratifying to note that as the mining industry increases throughout the state, modern improvements are introduced, work is made easier, greater facilities are readily forthcoming, the cost of extracting ores is reduced and the science of mining is becoming so systematized that properties carrying low grade ores can be worked profitably.

"More care for the safety of the miners is now being exercised, as noticed in the greater number of precautionary measures adopted; also in the careful instructions given to employes and in the rules adopted in many mines.

"The improvement in ventilation throughout the state is noticeable and managers generally are looking after the health of their underground employes, and furnishing them with fresh air so far as can be consistently done.

"There are hundreds of good silver mines in Montana already opened which would be worked at once, and hundreds of others which would be opened and worked could the owners be assured of a steady paying market. I find very many gold properties and small mines are being worked now. Old gold mines that have lain idle or been abandoned for years are now being developed and many of them with good results. Prospectors during the past year have made many new discoveries and their search for the yellow metal will continue. While Lewis and Clarke county is a good gold producer, Jefferson county is also rich in the same treasure. Gold has been discovered in every county in the state in both placer and gold formation.

"I would recommend that all mines working below the 200-foot level should have not less than two exits. I consider that a valuation cannot be set upon the lives of those who work at such depth. Two or more exits supply the necessary fresh air and also means or ways of escape.

"I find the law governing the handling or storing of powder is fairly well complied with. With one single exception I have found no cause for complaint so far as a material violation of the law is concerned.

"I would recommend the use of chair indicators in all hoists. Their great value and use can hardly be estimated until after their utility has been demonstrated. These chair indicators will show the engineer at what station the chairs are in or when the shaft is clear for the passage of cage.

"I herewith give a table of accidents which have occurred since my incumbency. It is of some importance, statistically considered:

Year.	Fatal.	Non-Fatal.
1893	29	4
1894	27	19
1895	41	18

"While the average fatal is 28 and non-fatal 17 for 1893-94, the year 1895 shows an increase of 13 fatal and one non-fatal over the two preceding years. This is accounted for by the increased number of mines in operation in 1895.

"During my incumbency the number of mines inspected and miners employed therein are shown by the following tables:

Year.	Total Mines Inspected	No. Men Employed.
1893	56	4,399
1894	71	6,061
1895	82	6,337

"Of this number of mines inspected, there were in 1893 in Silver Bow county 28, in other counties 22; in 1894, Silver Bow 39; others 32; in 1895, Silver Bow 48; others 34.

"The coal mines in operation during these years were as follows:

Year.	No. Mines.	No. Men Employed.
1893	5	1,067
1894	7	1,021
1895	6	2,411

"The grand total of coal, and gold, silver and copper mines was as follows:

Year.	No. Mines.	No. Men Employed.
1893	61	5,332
1894	78	7,082
1895	88	8,758

"I will add to the total number of men engaged in steady mining, 1,242, who are working small mines and representing the large number of prospectors who are classed as miners. This gives a grand total of 10,000 men. I consider this number sufficiently large, as my estimate is made from actual observation and general information gathered in the mining districts."

Removal.

The Boston Belting Co., whose home office is at 256-258-260 Devonshire Street, Boston, notify us that on April 1st, owing to increasing business demands, their New York office will be moved to the large and commodious store at 100 and 102 Reade Street. They will occupy the ground floor, basement and sub-basement, carrying a complete stock of their manufactures, and they expect to have one of the handsomest mechanical rubber goods stores in New York.

THE PROGRESS IN MINING.

Abstracts From the Proceedings of the Mining Societies

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

MANUFACTURE, USE AND ABUSE OF DYNAMITE.—Mr. Harry A. Lee, Commissioner of Mines of the State of Colorado, has written the following able article on the above subject:

The Dangers of Dynamite Manufacture.—Under the most favorable conditions the manufacture of dynamite is a hazardous business, safety being entirely dependent upon the purity of materials used and the skill and care of the workmen employed. In the manufacture of explosives, as in all lines backed by American ideas and energy, the American product stands pre-eminent. Although the first plant was established in this country only a little over 20 years ago, the art has to-day reached that point of perfection, brought feats of engineering within the range of possibility and exerted an influence upon modern civilization, which entitles it to take rank with the application of steam power.

The aim of the various powder companies is to supply a product which can be transported and handled with safety, which will give uniform results in blasting, keep in good condition when properly stored, and, as far as possible, neutralize all poisonous fumes when exploded. The explosives used almost universally throughout Colorado are compounds having nitro-glycerine for a base, commonly called by the miner "30 per cent. powder" or "60 per cent. powder," according to percentage of nitro-glycerine in the mixture.

The strength of the American nitro powder is not, as is generally supposed, wholly dependent for force upon the amount of nitro-glycerine present in the mixture. The compound is composed of various elements which in manufacture not only absorb the desired amount of nitro-glycerine but are in themselves an explosive. In blasting, the exploder or cap, which is charged with fulminate of mercury, explodes the nitro-glycerine and the nitro-glycerine, in turn, the remainder of the mixture. A line of experiments, conducted by experts, shows that the force exerted by this combination exceeds that of the sum of the three exploded separately.

The American dynamite of to-day is not an accident, but is the result of a long line of careful experiments, conducted by eminent chemists, and demonstrated by practical tests. These tests, aided by great advances in the art of manufacturing, have demonstrated that the products can be handled with greater impunity than many other things common to transportation by common carriers. They have also demonstrated that the safety of the compound is dependent upon purity of materials used and care in mixing. During the past few years competition among various powder companies has been so keen and bitter that gradually but steadily the cost of dynamite to the consumer has been reduced. It is a dangerous contest and a rivalry in which, sooner or later, if continued, safety will be sacrificed. To be more explicit upon this point—skilled labor commands a certain price, likewise chemically pure nitro-glycerine, the two being the most expensive parts in the compound of dynamite; combined the product is a safe mixture. Unskilled labor and impure nitro-glycerine can be had for less money, but the product of this combination is a mixture subject to decomposition. Decomposition in such a compound is practically explosion. Decomposition may not set in for some time, and the great danger of the competition, in the manufacture and sale of dynamite, is that of forcing some of the competitors to use impure or cheaper materials and labor, in order to meet a lower price, and take chances upon decomposition not commencing before the stock thus manufactured is disposed of. This danger point may not as yet have been reached. The older powder companies have much invested and a reputation to maintain; the newer companies have much invested and a reputation to make. From the standpoint of safety, however, the bottom price is very little below the market price of to-day.

The Storage and Age of Powder.—Powder should be stored in a dry, cool and well-ventilated magazine built for that purpose. A brick or stone magazine is preferable to a frame, both on account of being affected less by sudden changes in temperature and freed from any danger of bullets from careless marksmen. When built of wood the frame, or studding, should be covered inside and out with boards and so set that the air can circulate all around, and the inner boards be but little affected by the heat of the hot sun.

Caps should not be stored with powder.

Regarding the age of powder—when powder has had proper care in manufacture and storage, decomposition will not set in. If there is no decomposition there is no chemical change, and under these circumstances powder 10 years old or older is just as good and safe to handle as powder 10 days old.

One of the main sources of accident is from thawing powder, and the only safe plan is the use of heat from hot water. The powder should not be dipped in the water, but placed in a water-tight vessel and the vessel set in hot water, or a regular powder warmer should be made. These vessels can be obtained from any of the mechanical firms or from the powder companies, at nominal cost. Do not place powder under or on a stove, or in the oven. Do not lay on boiler wall or on back plate of a boiler. Do not heat around a blacksmith forge, or over a burning candle. Do not lay on hot sand, or, in short, do not thaw powder with dry heat. Do not consider these precautions unnecessary, or reason that because you have done so many times there is no danger. An explosion is usually fatal, and numberless escapes in no manner reduce the explosive force.

Freezing Temperatures.—Powder freezes at from 40° to 44° F., explodes, when confined, at from 320° to 360° F. From a quick application of dry heat, powder is liable to explode at 120° F. A stick of powder heated to 120° F. can be held in the hand with little inconvenience, and this degree of heat is soon reached when placed under or about a stove.

That frozen dynamite is liable to explode from heat quickly applied has been demonstrated many times, and to ignorance, non-appreciation or carelessness of this fact, most accidents are due. If you have heated powder about a stove for years without harm, consider yourself fortunate and stop it. If the warning of those who make the powder has no effect, let the accidents constantly occurring from this cause convince you. If you cannot procure a powder-warmer, take a 5-lb. lard bucket, fill it with powder, and set in warm water. If you have no warm water, put some sharp rocks in the bottom of a larger vessel to keep smaller vessel off the bottom, surround the inner vessel with water and set two lighted "snuffs" about an inch long under the big can, throw an ore sack over the whole, and in a short time the powder is in good condition for use and no has risk been incurred. With slow heat thus applied, dynamite may be heated to temperature of boiling water with safety. Do not use frozen powder to load a hole. It is unfit for use. If it explodes at all it will do poor work. If it does not seemingly burn or explode, it may be smouldering or decomposing, and the dropping in of a spoon, a drill or the stroke of a pick or hammer may be sufficient to explode what is left.

Do Not Hurry Back to a Shot.—Constant care in preparing charge and loading will avoid "missed holes." Next to warming powder with quick, dry heat, "picking out a shot" is the cause of the most fatal accidents. If a hole "misses," do not be in a hurry to return, and especially if the hole was tamped close. More accidents are caused from supposed missed holes than from actual. A small, sharp rock may be tamped into a piece of fuse so that the fire will not pass that point for hours; this is often mistaken for a "missed hole." The hole is picked out, this particular rock removed and an explosion follows. To fully demonstrate this, put some V-shaped clamps on a piece of fuse and see how long it will take to burn by certain points. Long after the fuse is supposed to be out, loosen the clamps and see how quickly it will "spit" at other end. Some holes do miss fire and have to be picked out. In these great care should be exercised to clean down not nearer than 5 in. from cap, then reload with another charge, and, instead of using a small piece of powder, use plenty. A heavy charge on top may destroy the effectiveness of the lower charge, but it will explode it and get rid of a bad job. If the "collar" of the hole is simply blown off and the lower charge has not broken to bottom of hole, do not drop in a drill or spoon to see "how much hole is left"; leave it alone as long as possible. The lower powder may have frozen and all may not have been consumed.

Caps are charged with fulminate of mercury, one of the most violent explosives and one of the most unstable chemically, and may explode from the slightest jar or least amount of friction. The caps at all times should be stored well away from the powder and at no time in or round a miner's pocket.

Powder should under no circumstances be stored underground. Poor ventilation with damp air will produce decomposition and decomposition explosion. There is practically no danger in transporting powder in cases and especially when frozen. Even well-thawed powder will not explode from any of the jars occasioned by a wagon haul or pack train. A case dropped several hundred feet upon rock might explode, but separate sticks would simply break out of the wrapper and no explosion follow.

Powder will burn in the open air and not explode, providing the gases generated in the adjoining powder from the heat of combustion have room to escape. For example, place two boxes of powder side by side, open one and ignite, leave the other box closed. The burning box will not explode, but the heat will explode the closed box.

* * *

SAFETY LAMPS AND SHOT FIRING IN MINES. The following is taken from an article in the *Pottsville Republican*, that was contributed by a mine foreman.

The safety lamp not a safe gauge of gas.—Personally speaking, and we have only our individual opinion to express, even though our say so don't make it so, we have never yet seen a real safety lamp, one in which a miner could with any degree of safety repose confidence. In the hands of a thoroughly practical and reliable man the Davy is an excellent detector, but in the hands of a careless or inexperienced person it is an instrument of destruction, being so constructed that a current having a velocity of eight feet per second will force the flame through the gauze and ignite the explosive mixture, or, where the current has a velocity of four feet per second and the velocity of a miner running from a blast or to escape a threatened fall of coal of rock, is equal to eight feet, the same result follows. Again, how frequently do we find instances where the miner hangs a "safety lamp" at the top of a prop as a warning of the approach of gathering gases; while his mind is occupied with some other duties the lamp becomes filled with the burning seething gas and before he notices its condition the fine wires are burned away, and before he can reach and remove the lamp there comes a blinding flash, a deafening report and dozens, if not hundreds, of valuable lives are sacrificed, their souls hurled without a moment's notice from time into eternity, while loving wives and children are widowed and orphaned, thrown upon the mercies and of a cold and unfeeling world. The mine itself is turned into a seething hell, whose victims writhe in torment, and those who have not been killed outright meet death by the noxious fumes of the stealthy afterdamp or atmosphere from which the life-supporting oxygen has been burned away, to say naught of the pecuniary loss to the operators, for in many instances after an explosion we have a mine fire on our hands, entailing heavy loss. With these facts so plainly set before us, we must look for a remedy whereby the cause may be removed that the danger may cease to exist, for we must admit that the gauze of a lamp is too weak a barrier between life and eternity.

Adequate ventilation required.—An adequate system of ventilation must be our next recourse. On this subject mine officials vary materially in their opinions, not only in regard to the various types of fans in use, but also as to the system of distribution. To the everlasting credit of the officials of the P. & R. C. & I. Co. be it said that they have adopted a system of ventilation at their collieries which can be relied upon in almost every instance and under all circumstances. With largest and most improved type of fan, direct acting engines, airways of large area, few doors and many overcasts, the column ascensional wherever possible, with the conviction that we are as powerless to stop the flow of noxious gases from the strata as we are to prevent the fall of rain from the heavens, and, regardless of expense, they are determined to pass through their workings such a quantity of air as will dilute and render harmless that hideous enemy of the miner. Their reward has been that although they own and operate some of the most gaseous mines in the anthracite basins, their quota of fatalities from explosions of gas is decreasing steadily, and if the employes would carry out the instructions of their superiors, who, as a rule, are men of a high order of intelligence, loss of life from this source would be indeed a rare occurrence, thus proving that if more time had been devoted to ventilation in the past, the appalling chapter of fatalities need never have been recorded.

Accidents from falls and blasting.—The fatalities resulting from this source are of every day occurence, and as long as the workmen will take the foolhardy risks which they do there can be no remedy. Seventy-five per cent. of these accidents are due to criminal carelessness on the part of the victim, insufficient timbering, undue haste in returning to the working face before the smoke from a shot has passed away. Neglect in dressing off the loose wings of coal from the rib or sides, too much confidence in the strength of top slate or coal, delay in taking down doubtful material or in making necessary examinations, greed or haste to load a large number of cars or take out a large amount of yardage. The object is gained, but eventually the miner or laborer pays the penalty with his life.

Josh Billings once said "Powder in itself is harmless; it is the fire makes it dangerous." Who among our miners would think of walking into a powder mill with a lighted cigar in his mouth? None you, say. Yet it is surprising the number of them who will sit in a pillar heading of about twenty-four square feet area, with a keg containing twenty-five pounds of powder in their arm, a naked lamp on their head, and very often a burning pipe in the mouth, and pour the loose powder into a paper shell, or tin can. Comment is unnecessary.

When shots have been charged with fuse the most careful miner will at times bruise or injure the fuse, so that the blast will fail to explode. Under no circumstances return to the face under twenty-four hours' time, and warn others to keep away.

Where shots are charged with the needle and fired by patent squibs, the squib is provided with a match of sufficient length to allow of the escape of the miner; if "touch" or gas squibs are used, the match should be lighted with "touch" paper, but never by a lamp or other blaze, as a slight waver of the air may cause the flame to reach the powder, and the result is invariably death. Do not tamper with the squib, and after lighting it give it ample time to explode the charge, for by returning too soon the miner is generally forced to pay for his haste with his life, and his name is added to the lists of deaths from "premature explosions."

Accidents on the roads.—A good rule to guard against this class of accidents is to enter the mine, proceed at once to your own working place, devote your time and attention to your own particular business, and, on leaving, guard yourself against moving cars, take time in getting on or off cars or cages, obey to the letter the mine law and the orders of your foreman and his assistants, and you will materially aid in reducing the chapter of accidents and preserving your own health and safety.

* * *

COLLIERY EXPLOSIONS AND COAL DUST.—(From the *Colliery Guardian*, by James Ashworth, M. E.) Again we have to deplore a colliery explosion in a district which is unfortunately noted for the magnitude of such accidents, but if on this occasion we are fortunate enough to gain an intelligible insight into the cause, the propagation of such explosions, and the way in which the forces generated expend their energy, we shall have gained information which, when practically applied, will conduce to the prevention of such great disasters in the future, and also in some measure atone for the sacrifice of human life and property in past explosions.

Many of our scientists have, in the course of experiments not directly connected with colliery explosions, discovered and elucidated facts bearing on this subject, and accompanied these facts with such sound reasoning that if their discoveries could be tabulated and brought to our notice we should be able to accept them without indulging in the small doubt which is popularly represented by the proverbial grain of salt. To enumerate these scientists would be a difficult task, and any attempt to do so would inevitably result in the leaving out of many whose useful and unostentatious labors entitle them to inclusion, and therefore the non-reference to such in the following paragraphs must not be thought to imply that their labors have been useless. One scientist whose labors appear to the writer to be especially applicable to this subject is Professor P. Phillips Bedson, D.Sc. of the Durham College of Science, Newcastle-on-Tyne, who has shown us that certain gases are occluded in coal dust, and that these gases are not of the same composition in all cases. Thus we know that fresh coal dust contains gases of the denser hydrocarbons, and that the enclosed gases are retained with varying degrees of firmness, also that the lighter gases, such as marsh gas and hydrogen, are the most readily removed. We also know that this fresh coal dust, being extremely fine, allows of the ready diffusion of its lighter gases (*a*) into the air, while the denser gases (*b*) remain for a time, and thus form the chief combustible constituents of the fresh deposited dust on the roadways. He has further proved that these denser hydrocarbons also in time diffuse into the air and are replaced by condensed oxygen (*c*). Thus we find that we have at the outset a most dangerous mixture, consisting first of coal dust lightly floating along in the ordinary ventilating current of the mine, and supported by the buoyancy of the gas which may be said to surround it, and which is continually diffusing, until at length it finds a resting place on the top of the timbering or on the roughnesses of the sides of the roadways. We have no means of readily estimating the quantity of gas thus continually present with us, but when such dust passes through a safety lamp, say, one burning hydrogen gas as its testing flame, it is at once seen that the presence of this dust makes the flame luminous, and therefore vitiates any test which we may desire to make for very low percentages of fire-damp. This fact alone shows us that the floating coal dust is of a very inflammable nature, and it will be even more evident when we consider that we have on the timbering and roughnesses of the sides of the roadways three layers of coal dust containing gases diffusing and diffused, thus, at the bottom, condensed oxygen (*c*), above that the denser hydrocarbons (*b*), and at the top of all, the lighter gases (*a*), finally diffusing from the newest coal dust.

Having now discovered what explosive ingredients lie hidden in coal dust, we next need to ascertain what information is available as to the temperature at which the above mentioned gases are given off. Professor Bedson tells us that the greater portion are given off at the temperature of boiling water, and that this fact is most emphatically true with regard to the lighter gases. He has also called our attention to a recent demonstration by Professor Victor Meyer, viz., that explosive mixtures of oxygen and ethane (C_2H_6) ignite at lower temperatures than similar mixtures of oxygen and marsh gas. And, further, that the Austrian fire-damp commission was led to conclude from the experiments they made that the sensitiveness of dusts increases with the proportion of easily-inflammable hydrocarbons, especially with the amount of ethane liberated at 100° C., and with the dryness of the dust. With respect to this question of dryness, it is to be observed that the Prussian fire-damp commission found the exactly opposite result in the course of their experiments—viz., that the drier sorts of dust gave the shortest flame. As to which of the three classes of dust previously named is the most dangerous, Professor Bedson says that that which by long exposure has absorbed a considerable volume of oxygen (*c*) must necessarily be easily ignited, and may lead to violent and explosive combustion. There is another point to note here—viz., that if the smallest percentage of fire-damp is present with coal dust, the burning effects are much more intense and the dust is more easily ignited. The importance, therefore, of knowing what gases are occluded in various seams of coal is clearly demonstrated.

Having found that gas is readily given off from coal dust at 100° C., we now want to know what degree of heat is sufficient to ignite coal dust. Again, taking Professor Bedson as our authority, and some of the upper dust from an engine haulage road in Washington colliery, adjoining Usworth colliery, as given in Messrs. W. N. and J. B. Atkinson's book on "Explosions in Coal Mines," as our sample, and which on analysis was found to consist of—

Moisture	2.5
Volatile matter	24.5
Fixed carbon (by difference)	57.8
Ash	15.2
	100.0

and also contained 1.69 per cent. of sulphur, we find that its temperature of ignition lay between 190° and 200° C. (374° and 392° F.). Another list of Professor Bedson's analyses may also be added from the same book, as they not only throw further light on the question of moisture, but are obtained from dust collected only thirty-three days after the Usworth colliery explosion and from the field of that colliery explosion:

	Moisture and volatile matter. Per cent.	Moisture. Per cent.
1. Coal dust from the floor near the shaft end of the stone drift	28.79	3.06
2. Coal dust from the air pipes in the stone drift	24.81	3.21
3. Coal dust from the floor of the crosscut haulage road	30.16	2.25
4. Coked coal dust from the traveling way between the middle and low north	20.41	1.70

Specimen 2, from the flanges of the air pipes in the stone drift, had feeble coherence, and may have been slightly coked. Further and more detailed information with regard to the ignition heat of coal dust will be found in Professor Bedson's report, as a member of the committee of the North of England Institute of Mining and Mechanical Engineers, appointed to inquire into a mysterious explosion which occurred in the air receiver and delivery pipes in the pit of an air-compressing plant at Ryhope colliery, on the 1st of March, 1880. In five out of ten experiments with 10 oz. of coal dust, ignition took place, with the temperature of the bath varying from 291° to 320° F. In none of the cases did the time from which the dust was placed in the bath to the moment of ignition exceed one hour. It was observed in every case in which ignition of the dust took place that immediately after the thermometer immersed in the dust began to rise, a peculiar odor, like "gob stink," was noted, soon followed by a rapid rise of temperature and a commencement of the burning of the coal was noticed by the experimenter. The readings of the air thermometer showed satisfactorily that after the coal dust reached the temperature of 356° F. the oxidation was then greatly accelerated and the thermometer rapidly rose to 392° F., after which it was no longer able to keep pace with the rise in temperature in the coal, then proceeding with such rapidity that in a few minutes—two or three—the coal took fire.

It was shown that with an easily oxidizable material, such as coal dust, it is only necessary to accelerate the oxidation by heating the dust in contact with air to a temperature within the limits of those likely to be reached in compressing air to 58 pounds in order to bring about the ignition of the dust. Two experiments were made with coal dust under air pressure, and it was observed that when the temperature reached 293° F. ignition took place, and that the combustion was vivid, and that a higher temperature was reached than when experimenting with air under ordinary pressure.

Principal Garnett, in reference to this explosion, said that there was one point he thought worth mentioning, and that was the increasing intensity of the explosion as it went down the shaft. The phenomena observed afforded a good illustration of what was known as "detonation" as distinguished from explosion. The explosion in the receiver started a wave of compression, which produced a sufficiently high temperature to cause the generation of combustible matter in the pipes. This combustion increased the temperature and the pressure, and thus a wave of compression went on increasing in intensity until it produced an explosion to further raise the temperature, and was capable of producing the stupendous effects observed at a distance of 200 fathoms from the receiver.

It has now been shown what gases may be found occluded in coal dust and also at what heat such coal dust may be ignited, and it remains now to consider, as being within the scope of this article, what gases are produced by mixtures of coal dust and air in the galleries of a mine. No actual sample of the after-damp produced from an explosion where coal dust has formed an important factor has, so far as the writer knows, been taken and analyzed. Mr. Atkinson took a sample some days after the Usworth explosion, but as this afterdamp was complicated with a standing fire, it cannot be accepted as a genuine sample of after-damp. The sample on analysis proved to consist of carbon monoxide 2.48, carbon dioxide 4.54, light carburetted hydrogen 8.68, oxygen 7.23, and nitrogen 76.80. With reference to this analysis, Messrs. Atkinson observe that carbon monoxide does not show on a safety lamp until the volume exceeds 10 per cent. The text-book composition of after-damp gives its most deleterious gases as carbon dioxide and nitrogen, but it has long been known that this statement was not found to agree with the effects produced underground, and it is now certain that Dr. Haldane, of Oxford, who was sent by the Home Secretary to examine the bodies of the men and animals killed in the Tylorstown explosion, and to ascertain the cause of death, will be able to say positively that the most fatal gas produced was carbon monoxide.

That there are other gases which have an important place in the composition of after-damp is also certain; thus, for instance, it is well known that explorers suffer from a smarting of the eyes and of the back of the throat, more often described as dryness. The writer was at one time of opinion that this smarting was caused by ammonia, but the late Dr. Carnelly told him that ammonia was only formed in actual colliery explosions by being distilled from the coal, as in the manufacture of ordinary gas, and that the smarting was probably due to oxides of nitrogen. Afterward, in the course of a lecture on "Colliery Explosions," he said "explosions in mines may possibly give rise to the production of oxides of nitrogen, and this may to some extent account for irritation produced in the eyes and throat on entering the workings after an explosion, for it appears that though the oxygen and nitrogen of the air unite directly with great difficulty under ordinary circumstances, yet they do so when a flash of lightning occurs, or simultaneously with the combustion of certain bodies in the air. Thus, if I burn some magnesium in this glass globe, it combines with the oxygen of the air, producing a brilliant light, and forms magnesia, but at the same time a small portion of the oxygen and nitrogen of the air unite to form oxide of nitrogen, which may be recognized by its smell, or better by dipping in the vessel a piece of paper moistened with potassium iodide and starch, which is turned blue, proving the presence of oxide of nitrogen. In a similar manner it is probable that the same substance may be produced during the combustion of fire-damp in air. Death by explosions is due not so much to the actual explosion as to suffocation by the carbonic acid or after-damp, and also to the highly poisonous action of the carbonic oxide—for the return fire proceeds backward so slowly that between the time of the actual explosion and the return of the fire to any particular point the atmosphere there will contain considerable quantities of carbonic oxide, and sufficient time will have elapsed for it to produce its poisonous effects."

A consideration of the initiation of a modern colliery explosion, based on the facts, experiments and analyses here tabulated, will make it quite clear that the actual presence of explosive gas, apart from that diffusing from and occluded within the coal dust, is not necessary to carry the explosion forward and throughout the whole length of the haulage road, because each particle of coal dust is either diffusing explosive gas or is charged with condensed oxygen. Moreover, the diffusion which is only proceeding at a normal speed may have this speed greatly increased by raising the temperature to or above 100° C. It has been shown, by quotations from Dr. Bedson's experiments, that compression of the air may not only raise the temperature to 100° C., and thus increase the speed of the diffusion of the contained gases, but that it will actually ignite the coal dust with the heat developed by the sudden air compression. When, therefore, a hot wave of sudden compression is set in motion by a blown-out shot or other cause, the instantaneous nature of the destruction of human life and property is clearly demonstrated. The chief thing necessary, therefore, to create an explosion in a dusty mine is the sudden production of sufficient energy at the point of initiation to produce a heat wave of high air compression, say 58 or more pounds per square inch, and that even greater energy than this is always exerted, may be calculated from one or more incidents of all large explosions, and as proved in one instance by Mr. A. L. Steavenson, who estimated that the mechanical force exerted had been equal to or exceeded 200 pounds per square inch.

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APPARATUS FOR EXPERIMENTING WITH FIRE-DAMP.—The following is taken from the *Colliery Guardian*:

A strong iron chamber for testing.—For the purpose of studying the action of various mixtures of air and fire-damp on the safety lamp flame, the mining engineers of Ostrau (Austria) have devised the apparatus forming the subject of the present paper, the main idea embodied in its construction being to establish the conditions actually existing in practice.

The main body of the apparatus consists of a case or conduit of strong iron plate fixed against a wall and supported by a couple of brackets clamped on to the latter. The case, which has a total length of about 4 m., is composed of two U-shaped pieces of plate, arranged laterally and connected by two flat plates forming the top and bottom, so that the transverse section measures internally about 40 × 40 cm. One end of the apparatus is left open, and into the other is inserted a jet for the admission of steam to induce a current of air through the case from the open end, the intensity of the draught being, of course, controllable by regulating the pressure of the steam issuing from the jet.

At about two-thirds of the distance from the open end of the case a circular opening is made in the bottom, and into the projecting collar from this is fitted a shouldered cylinder about 6 cm. or 8 cm. deep, forming a receptacle for the lamp. A small rectangular hole is cut at the side of the case for the purpose of observing the flame, and is closed by a pane of glass about 15 mm. thick. To deaden vibration and form an elastic cushion whereby the glass is enabled to stand the shock of explosions which would otherwise shatter it, a frame of caoutchouc is interposed between the glass and the iron plating. Two other square openings, fitted with covers are also situated near the lamp and are intended to act as safety valves in case the gaseous mixture becomes ignited. They are balanced by counterpoises, and the joints are made tight by a layer of caoutchouc; in this manner the apparatus is preserved from the risk of damage from the frequent explosions it has to withstand.

How the air and gas are mixed.—The air, after entering the open end of the case, passes through a plate of thin copper, perforated by twenty holes of exactly equal size; the dimensions of these apertures being accurately measured give the complete section of the current of air admitted into the apparatus. The fire-damp is introduced through a pipe fitted with a regulator cock. This pipe, terminating at a distance of about 1.50 m. from the the lamp, ends in a lyre-shaped box of copper surrounding the outer case, the two arms being pierced by a couple of holes on the inner side, and united by a copper pipe passing through the walls of the apparatus by way of a couple of perfectly tight joints and pierced by a great number of openings, through which the gas streams in. Before reaching the box the gas is made to pass through an arrangement to enable the section of current entering the testing apparatus to be accurately determined. This is effected by interposing between two joints a metallic plate pierced with holes of known diameter. In this manner the amounts of air and gas entering the apparatus are known exactly.

In order that the experiment may be conclusive, it is necessary that the gas and air shall be intimately mixed by the time they reach the lamp. For this purpose the mixture is made to pass a series of baffles of various kinds which have the effect of finally making it homogeneous. In the first place there is a copper plate pierced with a series of small holes to reduce the sectional space. This is followed by several sets of vertical rods, which mix the gases still more, and finally by three plates of wire gauze of very fine mesh placed close together and which complete the operation. The regularity of the mixture has been demonstrated by taking a number of samples, all of which showed the same percentage composition. Another function performed by the gauze plates is to prevent the lighting back of mixtures exploded by the lamp.

The volumes of the mixed gases.—The apparatus is, however, incomplete, without an arrangement for determining the quantity of gas and air under test, and for this purpose a couple of pressure-gauges are required, one to measure the pressure of the air and the other to indicate the pressure of the fire-damp, the former being in communication with the open air, and the latter connected at both ends with the pipe conveying the gas to the testing apparatus. Both work in the same manner, one measuring the pressure of the air in relation to that of the atmosphere and the other the pressure of the fire-damp entering the box, as compared with that existing in the mine, this latter being known precisely.

Working exactly alike, a description of one of these gauges will suffice for both, if the modifications in the second one be detailed. The gauge is formed of a column of copper, graduated in millimetres, of triangular section, but with one of the points of the triangle replaced by a rectangular strip. Two runners connected by a screw to regulate their distances from each other, move along the column. This screw engages in a fixed nut on the lower runner and moves freely in a collar on the upper one, so that—as will be readily understood—by turning the screw one way or the other the runners can be fixed at any desired distance apart. The movement is controlled and excessive separation prevented by a semi-circular spring. The upper runner has attached to it, at the side, the measuring bottle fitted with a vernier sliding over the graduated scale. This bottle terminates below in a caoutchouc U tube, which itself forms a continuation of the glass column of the pressure-indicator. Another caoutchouc tube connects the column with a mouthpiece leading into the testing apparatus.

The mode of working the apparatus is simple. Whilst the internal pressure exactly balances that on the outside, the water in the bottle is adjusted to the level of the zero of the gauge, and thus the super pressure is determined.

LEGAL DECISIONS ON MINING QUESTIONS.

(Reported for THE COLLIERY ENGINEER AND METAL MINER.)

Mining; The Right of Support.—Where the mineral estate in land is severed from the surface by a conveyance, the owner of the former is bound to leave enough of the mineral in place to support the surface, unless the owner of the latter has released his right of support. The release must be by express words or by necessary implication.

Robertson v. Youghiogheny River Coal Co. (Supreme Ct. Pennsylvania) 33 Atlantic Reporter, 706.

Engineer and Draughtsman; Partner or Employe.—A contract reciting that in consideration of a salary of a certain amount per annum paid by a firm to a party, and a further consideration of a certain share in the net profits of the business of the firm, the second party agreed to devote his time to their business as an engineer and draughtsman, is a contract of employment and not of partnership.

Porter v. Curtis (Supreme Ct. Ia.) 65 N. W. Reporter, 824.

Unsafe Place to Work in Mine.—In an action by an employe of a mining company for injuries due to the falling of the roof of a coal mine where he was working, evidence of the condition of the roof for a year prior to the injury, when connected with evidence of the existence of the same condition until the injury, is admissible to show notice. It is also proper to admit evidence showing that the part which fell could have been propped up.

Island Coal Co. v. Neal (Appellate Court, Ind.) 42 N. E. Reporter, 953.

Mining Claims.—In an action to determine the right to proceed in the United States land office for patent on certain mineral land, a party having offered in evidence the receiver's receipt for entry thereon, which by the laws of Montana is prima facie evidence of title to the land, the one sued may give in evidence decisions of the land office, made on a protest against the issuance of patent to the first party, cancelling the receipt for fraud in obtaining it.

Murray v. Polglase (Supreme Ct. Montana) 43 Pacific Reporter, 505.

What Constitutes a Mining Lease.—A contract reciting that the land-owner assigns to the other party all minerals on the land for a term of years, "to farm," and that such other party shall have the right of way over the lands on condition that he pay the land-owner a percentage of the profits made from mining the minerals, is a mining lease which is forfeited by failure on the part of the lessee to mine the minerals within a reasonable time.

Shenandoah Land & Anthracite Coal Co. v. Hise (Supreme Court App. Va.) 23 S. E. Reporter, 303.

When Lien Will Not Attach to Mining Property.—Where in an action to foreclose mechanic's lien it conclusively appears from the record that credit was given to the party in possession of the property under an option to purchase and not to the owner of the property, such liens will not, on the failure of the party in possession to whom credit was given to avail himself of his option be enforceable against the owner of the mining property.

Steel v. Argentine Min. Co. (Supreme Court, Idaho) 42 Pacific Rep. 585.

Conclusiveness of Surveys.—The official survey made of a Mexican land grant, after the grant has been confirmed by Congress, is conclusive as against any collateral attacks in the courts, and in an action to quiet title, by one claiming under the grant lands lying within the survey, against one claiming the same under a subsequent homestead entry, evidence by the latter that the survey was incorrect and that a correct survey would have excluded the lands in question, is inadmissible.

Colorado Fuel Co. v. Maxwell Land Grant Co. (Supreme Ct. Colo.) 43 Pacific Reporter, 556.

Pneumatic Drilling Tools—Patentable Invention.—Patentable invention was involved in bringing together, and adapting in size, proportion, and relation, the various parts necessary to form a cylindrical pneumatic drilling tool, which may be held in, and guided by the hand, while at work, even though like parts, operating by steam or air, in engines of various sorts, were previously known. Therefore the Bates patent, No. 364,081, for a pneumatic drilling tool, is infringed by a tool made in accordance with the Drawbaugh patent, No. 472,495.

Fisher v. American Pneumatic Tool Co. (U. S. Cir. Ct. App.) 71 Federal Reporter, 523.

Sufficiency of Proof of Mining Partnership.—Where it appeared, on an issue as to whether a party suing and another were partners in working a mine, that the lease thereof was in the name of the first party and a third person, because the latter would not have the name of the second party in it; that an alleged written partnership agreement was lost, and the testimony relative to it was vague and indefinite; and that it was not shown that the second party ever participated in the working of the mine, or shared the profits and losses; but that the first party assumed ownership and control, the Court of Appeals of Colorado held that there was no sufficient proof of partnership.

Hodgson v. Fowler, 43 Pacific Reporter, 462.

Hazardous Employment.—In an action to recover damages for the loss of a hand, it appeared that the party suing had been employed to drill holes, was directed by his foreman, without being instructed or questioned as to the nature of the attendant danger, to draw a charge of gunpowder and dynamite; that this party was experienced in gunpowder blasting, but did not know that the charge contained dynamite; that in his efforts to draw it, it was exploded. The court held that negligence was chargeable to the foreman, but not the party bringing the action; but that in such an action, the direction of the foreman was that of a fellow servant, and not that of the employer.

Vitto v. Farley (Com. Pl. N. Y. City) 36 N. Y. S. Reporter, 1105.

Coal Mining in Indiana: Weighing Product.—Act March 2, 1891, Laws of Indiana, requires coal mined under contracts providing for payment by specified quantity to be weighed before being screened and the full weight credited to the miner, provided that the payment for impurities loaded with or among the coal shall not thereby be compelled; section 7 provides the penalty. The Supreme Court of that state holds that, a conviction for failure to weigh before screening was improper, where the evidence for the prosecution showed that the coal mined was of such character that it was impossible to weigh the coal before screening, and credit the miner with the weight, without giving him credit for the impurities among the coal.

Martin v. State, 42 N. E. Reporter, 911.

Mining Partnership.—Where tenants in common in a mine form a partnership for the operation of the mine, without the mining property being brought into the partnership as a portion of the capital stock, the property does not for the purpose of payment of partnership debts become partnership property, as between a purchaser of one partner's interest in the mine and the remaining partners. In such a case the purchaser, as incoming partner, does not become liable for debts contracted by the partnership prior to the time at which he became a member. A member of a mining partnership is liable, as between the parties, for his proportionate share of the salary of an employe appointed by a majority of the members over his objection, such partner having reaped the benefit of the employment.

Patrick v. Weston (Supreme Ct. Colo.) 43 Pacific Reporter, 446.

Liability of Director of Mining Corporation.—The law of California declares it the duty of the mine superintendent to file weekly and monthly accounts and reports, verified under oath, showing receipts, disbursements, number of employes, and wages paid, reports to be kept in the office of the company, open to inspection of the stockholders. It further provides that in case of the failure of the directors to have the reports and accounts made and posted as provided, they shall be liable to an action by any stockholder, who, on proof of the failure, shall recover judgment for $1,000 liquidated damages. The Supreme Court of that state held that, the statute being remedial, and there being no ambiguity in it, recovery could be had of the directors for failure to have the accounts and reports of the superintendent verified by him, though they were full, true and correct, and there was no one within many miles of the mine who could administer oaths, and the directors acted in good faith, and had been advised by counsel that it was not necessary to have them verified. Under such statute, it is not necessary to prove damages. They will be implied from its violation.

Shanklin v. Gray, 43 Pacific Reporter, 399.

Pollution of Stream by Mining Company.—The Court of Chancery of New Jersey holds that, it is no defense to a bill by a riparian proprietor to restrain a mining company from polluting by discoloration, the stream, to show that the discoloration is the natural and necessary result of mining operations prosecuted in the ordinary way. Such result may amount to a nuisance, and its maintenance cannot be legalized by the legislature, even upon terms making compensation for the damage, and where the right is clear, and the facts undisputed, a court in equity is bound to give preventive relief; to refuse it is to allow such mining company to take the property of another upon terms of paying such compensation, from time to time, as a jury may allow. Where there is some danger of the occurrence of the discoloration in the future, the decree establishing the rights of the complainant should include a provision for a perpetual injunction.

Beach v. Sterling Iron & Zinc Co. 33 Atlantic Reporter, 286.

Spur Veins and Measure of Damages.—Where a party is adjudged the owner of a vein, having its apex within his location, dipping to the north, and extending under the location of another company, which lay north of this vein; and it appeared that there were certain ore bodies lying south of the vein and under it, with reference to vertical location, and that the ore had been taken by such company from such bodies, such ore bodies, since they could upon no theory have a separate existence, extending through said vein, and giving them an outcrop on the location of the company, should be regarded as having some connection with and belonging to the vein of the first party, and thus entitle him to whatever was in them.

The proper measure of damages in an action against the company for unlawfully taking such ore, when the company was not a wilful trespasser, is the value of the ore taken, less the cost and expense of breaking it and bringing it to the mouth of the mine; and where the ore has been taken out by a lessee of said company, it having received a royalty upon the ore, such royalty may be taken as its net profit.

Colorado Cent. Consol. Min. Co. v. Turck, 70 Federal Rep. 294.

What Constitutes a Mining Partnership.—A contract providing that the one party should have a certain undivided interest in all ores extracted from certain mines, and should bear a proportionate share of the expenses in extracting the same, the other parties to have the remaining interest in the ores, and to bear the balance of the expense, and also that the first party should furnish a mill for concentrating the ore, the expense of concentrating and rental of the mill to be divided among the parties, renders them partners in the extraction of the ores, and a subsequent verbal agreement that the first party should receive a certain price for each ton of ore concentrated, to be paid from the proceeds of the ore, he to pay the rental of the mill, repairs and improvements, does not prevent the parties from being partners.

After the formation of a mining partnership, an agreement that one of the parties shall ship the ore after concentration, receive the proceeds, and pay out the money under the direction of another partner, who was to manage the mine, does not affect their relations as partners.

Ashenfelter v. Williams (Court of App. Colo.) 43 Pacific Reporter, 664.

Negligence of Vice-Principal in Mining Operations.—The Supreme Court of Colorado, in considering the question of responsibility of a company for the acts of its representatives, said: There are decisions which hold the master liable for any acts done by the vice-principal, whether they were such as relate generally to the duties which the master owes to his servants, or whether the acts be merely on a level with those of a fellow-servant; but, the better rule, as we extract it from the best reasoned cases, is that for the acts of the vice-principal, done within the scope of his employment, and such as properly devolve upon the master in his general duty to his servants the master is liable; while for all such acts as relate to the common employment, and are on a level with the acts of the fellow employe,—except such acts as are done by the vice-principal against the reasonable objection of the injured servant,—the master is not responsible. In other words, the test of liability is the character of the act, rather than the relative rank of the servants.

Deep Mining & Drainage Co., v. Fitzgerald, 43 Pacific Reporter, 210.

Location of Mining Claims.—A party discovered a mineral lode, and posted on the spot a notice claiming the right to locate 1,500 feet on the lode and 300 feet on each side of it, naming it the "R. J. Lode" and also claiming the right to have 20 days in which to complete his boundary monuments. He afterwards went to the premises to mark the boundaries, but was prevented by sickness, but within 20 days he agreed with three other persons to give them half the claim if they would complete the location, which they did by setting up monuments at the corners and on the lines, and posting a location notice, describing it, in which the claim was called the "R. J. Gold, Silver and Nickel Quartz Mining Claim." The United States Circuit Court of Appeals held that the location made by the associates was a completion of the claim made by the first party, notwithstanding the addition of descriptive terms to the name of the claim in the notice posted by them. Also, that the first party had a right to transfer by parol an interest in his right to locate his claim to his associates, and his doing so and permitting them to complete the location was not an abandonment of such right.

Also, that the discoverer of a mineral vein should have a reasonable time after his discovery to complete his location, the length of time depending on the nature of the ground, the means of marking it, and the ability to ascertain the course or strike of the vein, and that in the case stated 20 days was not an unreasonable time, the vein being situated on a rough mountain side, the dip not exposed, and 1,000 feet of the vein covered.

Doe v. Waterloo Mining Co. 70 Federal Reporter, 455.

Safe Place for Employe to Work In.—Evidence that a rock fell from a place where a party had been blasting, striking one of his employes, at work below, and that a prudent examination would have detected the danger, shows a failure of the duty of the employer to provide his employes a place in which to work. The court said: A fair opportunity to avoid harm is sufficient to impose upon a person the peril of his conduct, if, when judged by common experience, he is blameful for his act. It may now be assumed that the stone which fell and produced the injury had been detached and loosened by a blast two or three days prior to the injury. Ordinary knowledge and experience teach us that the inspection and examination of the rock would have detected the insecurity and danger of the place where this man was set to work. The menacing position of the stone was easy of discovery. Under the rules, the employer was bound to give the reasonable inspection that a man of ordinary prudence would give. He was bound to see whatever a prudent, intelligent man would have foreseen. Negligence arises from imputed or presumed foresight. In fact, negligence may be said to be want of foresight. The circumstances that make men liable for their acts or omissions must be determined by experience; that is, whether the circumstances under which an act is committed are sufficient to sustain a charge of negligence must be determined by the common experience of mankind. The care which the law demands of the employer cannot be delegated to an employe, so as to exonerate the employer from responsibility to an employe who has sustained injury by reason of its nonperformance. Very different are the duties which the law imposes upon the employe; while he accepts the risks and hazard of the service in which he voluntarily engages, and must contribute the exercise of his faculties, he may assume that the employer has performed his duty and used all reasonable diligence to make the place where he labors safe and secure. He assumes only the risks which are ordinarily incident to the employment, from causes which are open and obvious, or which are announced to him in advance. He does not assume the risk of his employer's negligence, and the latter is negligent if he fails to discover insecurities and dangers which could be determined by the exercise of reasonable care.

Perry v. Rogers (Supreme Ct., 2nd Dept.) 36 N. Y. S. Reporter, 208.

TEMPERATURES AT GREAT DEPTHS.

At What Depth and Temperature Can Miners Work?

Mr. Agassiz says, for several years past he has, with the assistance of the engineer of the company, Mr. Preston C. F. West, been making rock temperature observations as they increased the depth at which the mining operations of the Calumet and Hecla Mining Company were carried on. They had now attained at their deepest point a vertical depth of 4,712 ft., and had taken temperatures of the rock at 105 ft.; at the depth of the level of Lake Superior, 655 ft.; at that of the level of the sea, 1,257 ft.; at that of the deepest part of Lake Superior, 1,633 ft.; and at four additional stations, each respectively 550, 550, 561 and 1,256 ft. below the preceding one, the deepest point at which temperatures have been taken being 4,580 ft. They proposed when they had reached their final depth, 4,900 ft., to take an additional rock temperature, and to then publish in full the details of their observations.

In the meantime they thought it might be interesting to give the results as they stood. The highest rock temperature obtained at the depth of 4,580 ft. was only 79 degs. Fahr., the rock temperature at the depth of 105 ft. was 59 degs. Fahr. Taking that as the depth unaffected by local temperature variations, they had a column of 4,475 ft. of rock with a difference of temperature of 20 degs. Fahr., or an average increase of 1 deg. Fahr. for 223.7 feet. "This," says Mr. Agassiz, "is very different from any recorded observations. Lord Kelvin, if I am not mistaken, giving as the increase for 1 deg. Fahr. 51 ft., while the observations based on the temperature observations of the St. Gothard Tunnel, gave for an increase of 1 deg. Fahr. 60 ft. The calculations based upon the latter observations gave an approximate thickness of the crust of the earth, in one case of about 20 miles, in the other of 26. Taking our observations, the crust would be over 80 miles, and the thickness of the crust at the critical temperature of water would be over 31 miles, instead of about 7 and 8.5 miles as by the other and older ratios. With the ratio observed here, the temperature at a depth of 19 miles would only be about 470 degs. Fahr., a very different temperature from that obtained by the older ratios of over 2,000 degs. Fahr.

"The holes in which we placed slow-registering Negretti and Zambra thermometers were drilled, slightly inclined upward, to a depth of 10 ft. from the face of the rock and plugged with wood and clay. In these holes the thermometers were left from one to three months. The average annual temperature of the air is 48 degs. Fahr., the temperature of the air at the bottom of the shaft was 72 degs. Fahr.

Mr. Edward Hull, in his work on "The Coal Fields of Great Britain," made an enquiry into the physical limit to deep coal mining, and he states that in Paris, at an artesian well sunk to 550 yards, the general result in chalk was found to be 1 deg. Fahr. increase for every 60 ft. beyond the normal; in Westphalia, a similar boring was carried to a depth of 768 yards, and the result was an increase of 1 deg. Fahr. for every 54 ft. Near Geneva an artesian boring gave 1 deg. Fahr. for every 55 ft. At Mondorf, says Mr. Hull, an artesian boring gave 1 deg. Fahr. for every 57 ft., and he gives details as follows:—

	Yards.	
Lias	59.15	about
Keuper	226.02	"
Muschelkalk	156.17	"
New red sandstone	342.00	"
Old schistose rocks	17.32	"
	801.26	

In the Tresavean mines in Cornwall, Mr. Hull goes on to say, the depth is about 2,112 ft. and the temperature was between 90 degs. and 100 degs.; this result would give an increase of 1 deg. for every 56½ ft. At the Monkwearmouth colliery, experiments showed an increase of about 1 deg. for every 60 ft. At the Dukinfield colliery, during the course of sinkings, the thermometer was inserted in a dry bore-hole and removed as far as possible from the influence of the air in the shaft, and left in its bed for a length of time, varying from half an hour to two hours. The sinkings went down at that time to 2,055 ft. There were also observations made in the open workings at 120 yards from the shaft, and at a depth of 2,151 ft. The first of these observations gave 51 degs. as the invariable temperature throughout the year at a depth of 17 ft. Between 231 yards and 270 yards it was nearly uniform at 58.0; and the increase from the surface, says Mr. Hull, would be at the rate of 1 deg. Fahr. for 88 ft. Between 270 and 309 yards the increase was at the rate of 1 deg. for 62.4 ft.; between 309 and 419 yards the increase was at the rate of 1 deg. for 60 ft.; between 419 and 613 yards the increase was at the rate of 1 deg. for 86.91 ft.; between 613 and 685 yards the increase was at the rate of 1 deg. for 65.6 ft. The result of the whole series of observations gives an increase of 1 deg. for every 83.2 ft.

Mr. Hull adopts 50.5 degs. Fahr. as the standard of departure—or, in other words, as the temperature of no variation at a depth of 50 ft. underground—and then adding 1 deg. for every 70 ft. beyond the first fifty, and taking into account the increased density of the air, he considers the theoretical increase of temperature at several depths would be found as follows:

Depth in feet.	Increase of temperature due to depth.	Increase of temperature due to density of air.	Resulting temperature.
1,500	21.42	5.0	76.92
2,000	27.85	6.5	84.85
2,500	35.5	8.5	94.00
3,000	42.14	9.83	102.47
3,500	49.28	11.66	111.44
4,000	56.42	13.16	120.08

Mr. Hull did not consider our miners could work at a higher temperature than that of 94 degs.—almost that of the tropics. But he thought it would be possible to reduce the heat even of a mine 4,000 ft. in depth to a degree not only tolerable, but admitting of healthy labor, and it was for that reason he fixed the limit of possible coal mining operations at 4,000 feet.—*American Journal of Science.*

FOUNDATIONS.

The Importance of Good Foundations for Machinery and How to Secure Them.

By Walter H. Mungall, B. Sc.

(From Transactions of British Society of Mining Students.)

The importance of a sound and unyielding foundation for machinery or other erections has long been realized, and at an early stage in the work of opening and fitting a new colliery, the engineer has to turn his attention to this subject. The first engine that is to be used in sinking a shaft requires to have a foundation previously provided for it. Boilers and chimneys; the permanent winding, pumping, and haulage engines; head-gear and screening plant all require foundations. In the present article, the subject will be dealt with only so far as it lies within the province of the mining engineer, and it is not intended to enter into any discussion of the theory of foundations.

A foundation in its simplest form consists of an excavation in the ground of such form and dimensions as will give a firm base for the superstructure. Such a foundation is all that is required for comparatively light structures, not subject to sudden and severe strains. But for most structures about a colliery such a foundation is quite inadequate, and the excavation is partially or completely filled with some material which will form a firm and solid base. In many cases, as for example in the case of a pulley frame, the area of the base of the structure is small in comparison with the weight upon it, and the pressure per unit area is consequently great, greater often than simple earth foundations can resist. To reduce the pressure per unit area it is customary to form the excavation of sufficient size, and subsequently to fill it with some solid material as masonry, brickwork, or concrete, through which the pressure is distributed to any desired extent. Before proceeding with the construction of foundations, the first thing to be ascertained, after an acquaintance with the nature of the ground, is the approximate weight to be supported, and the foundations must be so designed that the pressure per unit area will be well within the limits of safety. The direction of the pressure must also be taken into account, and the base of the foundation should be formed as nearly as possible at right angles to the direction of pressure upon it. As a general rule also, the line of the resultant pressure on a foundation should pass through the center of gravity of the foundation, or as near thereto as possible.

In some few cases a firm and sufficient foundation is readily obtainable on rock, in which case all that is necessary to prepare it for the superstructure resting on it, is to cut away all loose or decayed parts, and to hew or dress the surface of the rock to suit the form and pressure of the structure to be erected. When the surface of the rock is irregular, it may be necessary to fill hollows in it with masonry or concrete. It is customary in engineering practice to allow for stone structures a factor of safety of not less than eight, and for foundations on rock the pressure should not exceed, at any point, one-eighth of the pressure required to crush the rock. Experiments on the crushing pressure of rocks have from time to time been made by various engineers of eminence, the average results of some of which are given in the subjoined table:—

TABLE OF THE STRENGTH OF ROCKS.

	Crushing Stress, lbs. per sq. in.
Sandstone (strong)	5,000 to 9,000
" (weak)	2,000
" (ordinary)	3,000 to 5,000
Limestone, compact (strong)	8,000
" magnesian (strong)	7,000
" " (weak)	1,000
" granular	4,000 to 4,500
Chalk	200 to [illegible]
Whinstone (basalt)	9,000 to 17,000
Granite	6,000 to 11,000

Where the rock surface is not accessible for forming the foundation, the base of the structure has to be rested on the earth above the rock and the total pressure must be more or less distributed as the earth is softer or firmer. In firm earth, such as hard clay, clean sharp sand, or firm dry gravel, the greatest pressure in general engineering practice is from 2,500 to 3,500 pounds per square foot of bearing surface. For a superstructure that is in itself heavy, or that has to support a heavy load, or that is liable to severe strain, the foundation base must be made of such area that the pressure per square foot will not exceed the above limit. Usually the footings or lower courses of ordinary masonry or brickwork, as of an engine house, have an additional breadth or "spread" equal to one-and-a-half times the thickness of the body of the wall when built on compact gravel, or of twice that thickness when built on sand or stiff clay.

Before building on *soft* earth, additional precautions must be taken with regard to the foundations, and some other expedient must be adopted than those applicable to firm earth foundations. Of course there are degrees of softness, and no general rule can be laid down applicable to the variety of cases that may occur in practice. The simplest class of foundations on soft earth are those already referred to as applicable to firm earth, with this difference, that the base must be further increased to reduce the pressure per unit area. When softer earth, as peat moss, soft alluvial clay or silt, with, in some cases, a natural slope of one vertical to eight or ten horizontal, is met with, of considerable depth, other methods have to be adopted. These generally entail the use of timber or iron. Timber platforms are usually constructed by forming a grating of crossed beams of elm or oak which in turn is covered by planking on which the superstructure rests. The beams employed are usually from 10 to 12 inches square, and laid about three feet apart, the spaces between being filled with concrete.

The method usually adopted, however, for securing a good foundation in very soft ground is by piling. Piles are usually of square or round timber from 6 to 9 inches diameter for piles from 6 to 12 feet long, and larger in proportion to the length, the ratio of diameter to length being in general about one to twenty. In setting the piles they are placed as close together as practicable. When piles are driven to form a rectangular or circular foundation, the outer circuit of piles should always be driven first, the work being finished at the center. The piles may be surmounted by a platform as above described, or simply by a layer of concrete. The most suitable timber for making piles is elm. In general practice the limits of pressure on pile foundations may be taken at 1,000 pounds per square inch of head area when the piles are driven till they reach firm ground, or 200 pounds per square inch of head area when the frictional resistance between the timber and the earth is the only support. In all cases where timber is thus employed in foundations, care should be taken to keep it entirely removed from the influence of the atmosphere, and to keep it wet, otherwise it will soon decay.

Engine foundations, as a rule, require to be raised sufficiently high above the surrounding ground to give clearance for the fly wheel, drum, or gearing, or for other purposes, as also to form a sufficient weight to which to fix the engine. Engine foundations may be constructed of timber, brickwork, masonry, or concrete. For permanent work timber foundations are not to be recommended, as they are liable to early decay, but for temporary winding or pumping engines at a sinking shaft they form a convenient, simple, and cheap foundation. They are easily built and easily removed, and the material may subsequently be used for similar or other purposes.

One form of engine foundation, now almost obsolete, was built of ashlar masonry, the stones being of large size, each measuring about ten cubic feet, the usual dimensions being 4 feet by 2 feet by 15 inches thick. Stones of larger size are more expensive, and were consequently seldom, if ever, used. Undoubtedly this makes a very good foundation, but it is costly and is now generally superseded by brickwork or concrete.

Brickwork built with Portland cement mortar is in very general favor, and forms an excellent foundation. The bricks should be tightly built, the joints not exceeding a quarter of an inch in thickness, and the whole structure well bonded together so as to form, as nearly as possible, one solid block. The cost of this kind of engine foundation is considerably less than one of ashlar masonry.

For engine foundations, and, indeed, for all sorts of foundations about a colliery, there is much to recommend the use of concrete. It forms the best foundation, and is less costly than either ashlar masonry or brickwork. Concrete is essentially a species of rubble building, the stones of which are cemented together by a mortar, usually of Portland cement and sand or fine gravel. About a colliery where, as a rule, a plentiful supply of sandstone is readily obtainable, especially during sinking operations, it may with advantage be used in the manufacture of concrete. A quantity of stone is broken to about the size of ordinary road metal, or from 1½ to 2½ inches diameter. This is mixed with certain proportions of clean sand and of Portland cement, the proportions of the various ingredients varying with the purposes for which the concrete is to be employed. For ordinary foundations the proportions are generally about four parts, by measure, of broken stones, one part of sand, and one part of cement. These, after being thoroughly mixed, have sufficient water added to make the whole a plastic mass, which is forthwith transferred to the excavation or other receptacle previously provided for it. At the same time, a number of large stones may with advantage be thrown in, care being taken that they are thoroughly bedded in the concrete, which should also fill all interstices between them. When using sandstone for making concrete, it is not generally necessary to add sand, as in breaking the stone a quantity of sand is produced, unless the stone be very hard. By a little experience one can readily estimate whether there is a sufficient quantity of sand among the broken stones, and it becomes unnecessary to measure them out separately. Broken bricks, blast furnace slag, limestone and other materials are frequently used for making concrete. It should be noted that the concrete occupies only about two-thirds of the volume of the ingredients when unmixed.

When concrete foundations have to be raised above the level of the surface, a casing, usually formed of planks, has to be erected, of the form and height of the monolith, into which casing the plastic concrete is placed. After it has sufficiently set to permit of the casing being taken away, this should be done.

In conclusion it may be useful to compare the cost of building engine foundations of the three classes referred to. For a set of coupled winding engines, each foundation will contain about 40 cubic yards, or say 80 cubic yards in the two, and the total cost will be approximated as follows:—

80 cubic yards Ashlar masonry at 75s.	£300 0 0
80 " brickwork in cement at 16s.	64 0 0
80 " concrete (5 to 1) at 9s.	36 0 0

NOTE.—These figures for cost, will be interesting to American readers, as showing the proportionate cost of the three types of foundations. Naturally the British figures will not directly apply in America.

Contractors' Methods.

"Contractors' Methods, Employed on the Great Chicago Drainage Canal, 2nd edition," is the title of an interesting illustrated pamphlet just issued by the Lidgerwood M'f'g Co., of New York, Chicago and Boston. The book illustrates and describes the various appliances used on the canal, by means of which the stupendous work is being rapidly accomplished. A copy of this pamphlet should be in every engineer and contractor's library. It will be sent free on request by the Lidgerwood Co.

EXPLOSIVES

FOR FIERY AND DUSTY MINES.

The Report of the Flameless Explosives Committee of the North of England Institute of Mining and Mechanical Engineers.

The results of the labors of this committee are of great importance, and we, therefore, hasten to present to our readers an epitome of the facts established by their experiments.

The report begins with a statement that the experiments were conducted in mixtures of coal dust, air, and mine gas confined in a plated tube built like a cylindrical boiler, that was 3.5 feet in diameter and 45 feet long. At the rear end of the tube a cannon or steel mortar was fixed for firing, and it was in the bore 1.5 inches in diameter and 20 inches long. Three trays or frames were fixed in the tube, and each of them was 6 feet in length and of a breadth equal to the width of the tube at their level; the rear end of the first tray or the edge next the mouth of the cannon or shot hole was 15 inches, and its front end was 19 inches above the bottom of the tube, and the ends of the other trays in succession were at elevations of 11 and 13 and 7 and 13 inches. Some of the coal dust was scattered in the air of the tube, and the rest was laid on these trays. The rear end of the first tray was 10 inches from the mouth of the shot hole, and the rear ends of the second and third trays were at distances of 12 inches from the front ends of the first and second trays. The tube was fitted with escape valves and windows and an exhausting fan for removing foul air, and pipes and cylinders for injecting measured volumes of mine gas from the adjacent Hebburn colliery, and it contained 78.8 per cent. of combustible gas, that consisted of 61 per cent. of marsh gas. The material used for stemming or tamping was puddled clay. The coal dust was weighed before it was cast into the air of the tube or placed on the dust trays.

The following is a summary of the time occupied in making one of these experiments:

	Seconds.
Running the mine-gas into the tube	60
Mixing mine-gas and air with the fan	60
Putting in the coal dust	20
Mixing the mine-gas air and coal dust	15
Interval before firing the shot	3
Total time	158

It is almost needless to say that these experiments were conducted with intelligence and care, and are, therefore, reliable, and perhaps what is of prime importance about them is the conclusions that the committee have arrived at, and here are some of them:

"In the experiments with coal dust in suspension, it was difficult to ascertain the amount of dust which was actually in suspension in the air at the moment when a shot was fired.

"Only a small proportion of the coal dust placed in the tube appears to pass into actual suspension, and the heavier particles fall before the shot is fired. These experiments, therefore, are of a double nature, the greater weight of dust being *in situ*, and the lighter and more inflammable portions being in suspension.

"The experiments with coal dust in suspension appear to approach to the conditions generally prevailing in mines, in which the greater weight of dust is lying on the bottom, sides, roof, timber, etc., and a smaller weight of fine dust is floating in the air.

"The committee felt justified in adopting this method of obtaining the suspension of the coal dust, as it approximated to the actual conditions of the mine, and more especially as in the first experiments with unstemmed shots four of the safety explosives failed to withstand the test."

"On referring to the experiments made in gaseous mixtures of air and pit gas it will be seen that none of the explosives, when stemmed, caused an ignition of the gaseous mixture. It was therefore decided to make experiments with stemmed shots and mixtures of air and pit gas, with the addition of coal dust, the object being to ascertain whether the addition of coal dust to an explosive gaseous mixture would render it more susceptible of ignition.

"The Austrian firedamp commission found, after making a large number of experiments, that a small admixture of firedamp greatly increased the sensitiveness of coal dust to ignition. This danger requires especial consideration, although the above conclusion (based upon experiments with dynamite) was not wholly sustained by the experiments of this committee made with safety explosives."

EXPLOSIVES (UNSTEMMED) FIRED INTO MIXTURES OF PIT GAS AND COAL DUST IN SUSPENSION.

"*Roburite and Carbonite.*—Only roburite and carbonite were tested in this series of experiments. It was deemed unnecessary to test the other safety explosives when unstemmed, as each of them had ignited mixtures of pit gas or pit gas and coal dust at one time or another during the course of the several series of experiments. Roburite and carbonite, however, had in no single instance ignited such mixtures, either when the shots were stemmed or when unstemmed.

"In this series of experiments roburite ignited a mixture containing 8.03 per cent. of pit gas and 1 pound of coal dust, but carbonite did not ignite any of the pit gas and coal dust mixtures."

EXPLOSIVES (UNSTEMMED) FIRED INTO COAL DUST IN SITU.

"*Bellite.*—Three experiments were made with bellite; sparks were observed in two experiments, and nothing seen in the other experiment.

"*Ammonite.*—Three experiments were made with ammonite, a quantity of sparks being observed in each. In one experiment a flash was seen for a length of 7 feet, and in another experiment for a length of 53 feet from the cannon.

"*Roburite.*—Three experiments were made with roburite. Sparks were observed, without flame, in each experiment.

"*Carbonite.*—Three experiments were made with carbonite, neither flame nor sparks being seen.

"*Ardeer Powder.*—Three experiments were made with ardeer powder, without sparks or flame being observed.

"*Westfalit.*—Seven experiments were made with westfalit. In two experiments the charge was incompletely detonated, sparks were observed in five experiments, and flame in two experiments. In one experiment nothing was seen, and the charge was found to have been incompletely detonated.

EXPLOSIVES (STEMMED) FIRED INTO COAL-DUST IN SITU.

"Each shot was stemmed with 3 inches of damp puddled clay. The coal dust was not ignited in any of the experiments.

"*Bellite.*—There were seven experiments with bellite, including two experiments when the charge was incompletely detonated, and neither flame nor sparks were seen.

"*Securite.*—Three experiments were made with securite, and as the charge in each case was incompletely detonated, the stock in hand was condemned and the experiments were discontinued.

"*Ammonite.*—There were twelve experiments made with ammonite, including one experiment in which the charge was incompletely detonated; a flash at a distance of 45 feet was recorded in two experiments, and at 13 feet in one experiment, and in the other experiments neither flame nor sparks were observed.

"*Roburite.*—There were thirteen experiments with roburite, including three experiments in which the charge had been incompletely detonated; neither flame nor sparks were observed in any of the experiments.

"*Carbonite.*—Five experiments were made with carbonite, without flame or sparks being seen in any of the experiments.

"*Ardeer Powder.*—Five experiments were made with ardeer powder, and neither flame nor sparks were observed."

SUMMARY OF EXPERIMENTS WITH THE FOLLOWING EXPLOSIVES.

"*Roburite.*—The experiments made with roburite numbered fifty-three in all, and in no instance was the coal dust ignited. The quantity of coal dust, the method of placing the coal dust, and the duration of the running of the fan were varied from time to time during these experiments. Coal dust from Hebburn, Seaham, and Silksworth collieries was used. There was little or no appearance of flame, but sparks were observed in most of the experiments. In one experiment, included in these results, there was incomplete detonation of the charge.

"*Carbonite.*—One experiment only was made with carbonite, resulting in ignition of the coal dust. Two pounds of Hebburn coal dust were placed upon No. 1 frame, and the fan was revolved for about 10 seconds. There was evidence of considerable violence reaching to the end of the tube, resulting from this ignition of dust; Nos. 1, 2, 3 and 4 plugs were forced from their position, and the cannon recoil was considerable. There was no appreciable interval of time between the firing of the shot and the ignition of the coal dust; rolling red flames were observed for a length of 45 feet from the cannon, and sparks were seen, without flame, at 53 feet from the cannon.

"*Ardeer Powder.*—There were thirty-three experiments made with ardeer powder and in no instance was the coal-dust ignited. Variations in the quantity and in the method of placing the dust, and the period of the running of the fan were made from time to time. In one experiment, a second shot was fired into the tube about one minute after the firing of the first shot, without igniting the coal dust. No flames or sparks were observed during these experiments.

"*Westfalit.*—Fifteen experiments were made with westfalit, and in no case did it ignite the coal-dust. A quantity of coal-dust varying from 3 pounds to ½ pound was used in the experiments, and the method of placing the dust and the time of running of the fan were also varied. The experiments were made with coal dust from the Hebburn and Silksworth collieries."

The committee further remark: "The results of the inquiry point very conclusively to the unreliability of all of the safety explosives; contrary to the general opinion at the time when these experiments were commenced, it is proved that no explosive is flameless, and that all are capable of igniting gaseous or coal dust mixtures.

"Very interesting results have been obtained during the course of this inquiry. Firstly, the sensitiveness to ignition of coal gas, as compared with pit gas, has been clearly demonstrated. Secondly, the presence of flames in an explosive gaseous mixture has been proved (the flames sometimes being first observed at points several feet remote from the cannon), without ignition of the gaseous mixture ensuing. The retarded ignitions of explosive mixtures of coal gas and the point of first ignition of gas mixtures occurring many feet distant from the cannon are interesting features in the inquiry.

"Knowledge of this extensive subject—explosives—has only been obtained at the cost of much labor and expenditure from properly conducted experiments, and there still remains much to be done. Interesting results might be obtained by firing shots through a space containing atmospheric air into a chamber containing gas or coal dust mixtures. Many varieties of coal dust have not yet been tested, and little is known about the propagation of coal dust ignitions. By means of a constant current of air and coal dust, many interesting experiments might be made, and much useful knowledge gained.

CONCLUSIONS OF THE COMMITTEE.

The lengthy series of experiments, which have occupied the attention of the committee since March, 1892, appear to establish the following conclusions:—

1.—The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit) on detonation produce evident flame.

2.—The high explosives are liable to ignite either inflammable mixtures of air and fire-damp, or air and coal dust; or air, fire-damp, and coal dust, and therefore cannot be relied upon as ensuring absolute safety when used in places where such mixtures are present.

3.—The high explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire-damp, air and coal dust, and air, fire-damp and coal dust.

4.—The experiments have shown that ignitions of mixtures of air and coal dust, with or without the presence of fire-damp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary.

5.—It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used, should be rigidly observed where a high explosive is employed.

6.—In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened and not abolished by its use.

7.—In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge, and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges.

8.—As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to ensure their being maintained in good condition.

The North of England Institute of Mining and Mechanical Engineers deserves the praise of all the miners, mine engineers, and coal operators throughout the world, for they have done a good work, the benefits of which will not only be felt in the saving of life and property, but in directing the minds of those interested along the correct lines of further progress.

An Ignition of Coal Dust.

We have gathered the following facts concerning an ignition of coaldust that occurred in the No. 7 Eureka coal mine, Clearfield county, Western Pennsylvania, on January 19, 1896, at 4:40 p. m., when four men were burned, and two of the poor fellows severely.

There can be no doubt of the cause of this ignition, as the following narration of the particulars will show: It appears that a frozen dynamite shot was first fired in a hole at the bottom of a top bench of coal lying immediately on a parting band of stone, the object of the shot being to break down the stone after the bottom bench of coal had been taken out. This frozen shot, however, failed to do its work, for instead of shattering the stone

it pulverized the coal into dust at the back end of the hole, and from what followed we learn that this dust afterward supplied the fuel for the ignition under notice.

The first shot mentioned was drilled in the coal on left side of heading and close to the left side rib and in the coal directly over a 20-inch band of stone, and 6 feet deep, charged with 1¼ lbs. of dynamite, and was intended to break the stone down; but owing to the dynamite being at or near a frozen temperature, it was of insufficient power for the work intended and did not even break the front of coal, which resulted in a dull sounding shot and a confining of the gases given off from dynamite in the back of the hole, together with the pulverized coal from the effect of the shot.

The accompanying sketch shows the point at which the ignition occurred. When the second shot went off, the effects of the heat of ignition, and the mechanical effects of the sweep of the swiftly rushing air were remarkable, for coked dust was forced into crevices in the sides and cracks in the timbers, and the course dust lying on shelves of the coal walls and that lying on the top timbers was all charred, while the dust on the floor was swept up against the sides of the road. The flame swiftly moved 210 feet back against a ventilating current of 20,000 cubic feet of air per minute, and strange to say, it left untouched a can containing three pounds of powder, that was situated only 45 feet from the initial point of ignition by the shot.

Fatal Mine Explosion.

Four men were killed and four fatally injured in an explosion in the Rosslind mines at Winnepeg, Manitoba, March 20.

BLASTING IN FIERY MINES.

Methods of Reducing the Danger in Austrian Mines.

By Franz Brzezowski.

(Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen*, by *The Colliery Guardian*).

In view of the dangers constantly attending blasting operations in mines where fire-damp is present, attention has long been directed to the development of implements to replace explosives, as well as to such modifications of usual blasting methods as shall minimize the risk in question. Latterly the accident at Karwin has given a fresh impetus to the endeavors in progress in this direction, and led to results calculated to lessen the facility of explosion of the fiery gas. Such explosion is generally influenced either by the fuse or by the blasting charge itself. As regards the former, there are now several reliable systems of central-fire cartridges in existence, such as the electrical fuses (high tension, or quantity—the latter for choice, as offering less danger of igniting the gas by sparking); Tirmann's percussion detonator, which, out of 400,000 shots, only gave 0.2 per cent. of miss-fires; the improved Lauer friction fuse; and the Jaroljmek water-cartridge.

Much more difficult is the solution of the second problem—the ignition of gas by the explosive; although much has also been done here towards the attainment of the desired end. The main factors by which the safety of a blasting charge is influenced are: (1) The suitability of the explosive to the work it has to perform; (2) the diameter of the borehole; (3) the wrapping of the charge; (4) the strength of the detonator; (5) the mode of tamping; (6) the composition of the charge. In treating the above in order, it is, in the first place, manifest that when all the heat evolved on the ignition of an explosive is used up as mechanical disruptive energy, there will be less danger of an explosion of of fire-damp than in the converse event; wherefore, badly arranged borings should not be charged, but ought to be abandoned. In the second instance, a cartridge freely suspended in fiery air is more dangerous than a blown-out shot, the amount of surface exposed being greater, and for the same reason the danger from blown-out shots varies as the diameter of the borehole. The method of packing the charge, and particularly the kind of paper employed to cover the cartridge, seriously affects the safety of the shot under all conditions. On this account the Mahrisch-Ostrau special committee employed in their experiments a uniform wrapper of cellulose parchment paper in order that the results obtained should be capable of comparison. Paper soaked in ceresin has shown itself especially dangerous; asbestos paper or paper impregnated with water glass, on the other hand, behaves well.

Von Lauer's experiments go to prove that the disruptive power and therefore the danger of an explosive is modified by the strength of detonator employed, and it has been found with the Trauzl method the volume of gas evolved from 15 grains of explosive varied with the detonator as follows:

	Detonator cap.			
	1 grm.	2 grms.	3 grms.	
Wetter-dynamit	350	356	—	cubic metres.
Westfalit	550	546	648	"
Progressit	354	566	590	"
Fellfractor	—	560	—	"

The decrease of security resulting from the use of large detonators may be gathered from the fact that a blown-out shot of 500 grammes of westfalit fired by a 1-gramme detonator did not explode a 7 per cent. mixture of firedamp, whilst 300 grammes ignited by a 3-grammes cap under similar conditions did. It is, therefore, evident that the term "safety," as applied to these explosives, is only relative.

The effect of stemming is to decrease the danger of exploding firedamp by converting the evolved heat into energy, and in this respect water, sand, and moss tampings have proved particularly efficacious, but it was not until the recently published researches of Siersch on the photographic pictures given by various blasting materials when exploded, that the relative value of these methods could be accurately compared. At the invitation of the author, photographs were taken of the flash from 100 grammes of dynamite No. 1, fired as a blown-out shot in a mortar 30 mm. in diameter, 14 cm. from the mouth of the borehole, both open and stemmed; and in order to ensure the correctness of the observation the tests were repeated ten times, when the result that the moss was found to make such an effectual stemming that its employment, in conjunction with the Tirmann percussion fuse, has been made compulsory in the mines of the Archduke Friedrich at Karwin.

Concerning the constitution of the explosives suitable for fiery pits, "safety explosives," with the exception of "wetter"-dynamite (a mixture of dynamite and crystal soda), mostly consist of ammonium nitrate (up to 96 per cent.), mixed with aromatic hydrocarbon compounds (benzol, naphthalin, anilin) or their nitro-compounds, resins or fats, and can only be fired by powerful detonators, their safety depending on the smallness of the flame produced. These substances are completely harmless in themselves, being proof against shock, or flame, and can be handled with red-hot iron tongs or exposed to the flame of the oxyhydrogen blow-pipe without exploding, merely fusing and burning with a small flame, and ceasing to burn when removed from the fire. These properties are valuable for mining purposes, as none of these preparations give deflagrating shots. "Wetter"-dynamite will deflagrate if the detonator is insufficiently powerful, but the others under consideration simply refuse to explode, under similar conditions, and they have the further advantage over dynamite of not freezing except at very low temperatures—seldom, therefore, requiring to be thawed out. In fact, they can only be fired by means of very powerful caps, and the closer they are compressed the stronger will the cap have to be. When of a density of 1.6 to 1.7, a 2-gramme cap or dynamite fuse is insufficient. The most convenient density is 0.8. The dispersive power increases, and the security decreases with the proportion of hydrocarbon compounds, and with the strength of detonator employed. Ammonium oxalate or the salts of chlorine, bromine and iodine diminish the efficiency, but heighten the safety of these explosives. On the other hand, amongst the disadvantages may be noted their low density—which necessitates wider boreholes—and especially their hygroscopic power, which, however, may be counteracted by careful packing.

The only reliable method hitherto discovered for determining the comparative safety of these explosives, is by the photographic examination of the flame produced when they are fired. This, however, enables the following points, *inter alia*, to be solved, viz: The constancy of the flame under identical conditions, and how far the flame alone affords a sufficient indication of the degree of safety; that the danger of a particular charge increases with the diameter of the borehole. It will also assist in determining the limit of safety—as regards weight of charge—of a blown-out shot, *i. e.*, the maximum charge that can be used without producing an escape of flame from the borehole.

The value of "safety explosives" may be judged from the following experiments with "progressit," a preparation which for security is found to be surpassed by none: 150 grammes of progressit could not be exploded by a 2-gramme cap when lying free in a mixture containing 2 per cent. of gas and 3 kilos. of coal dust, whereas 300 grammes of No. 1 dynamite exploded with violence; 150 grammes of progressit lying free in presence of 10 per cent. of gas and 3 kilos. of coal dust were exploded by a 1-gramme cap, but failed to ignite the mixture in any of the ten tests applied, and in only two out of four cases did a 2-gramme cap explode the mixture; 400 grammes of progressit lying free in a mixture containing 7 per cent. of gas and 3 kilos. of coal dust and fired with a 2-gramme cap did not produce ignition.

The means at present at disposal for combating the danger of exploding firedamp in blasting are briefly: The central-fire cartridge; moss stemming; good quality paper for covering the cartridges; safety explosives (up to the minimum charge of each); removal of suspended coal dust by spraying; and finally, the entrusting of the operations to a skilled workman.

A Disastrous Explosion.

An explosion of gas at the Berwind-White Coal Mining Co.'s mine at Dubois, Pa., on the 23d ult., resulted in the death of thirteen men. The mine is a new one which the company has been opening up for some time. On the morning of the accident eighteen men entered the mine. Four of them went into the south heading, the remainder into the north heading. At ten o'clock a. m. the four men in the south heading felt a severe shock, and being joined by the mine foreman they started for the north heading to investigate the cause of the shock and render help if necessary. The men on the surface were notified of the explosion by the shock and the rush of air up the shaft. Help was immediately summoned from the neighboring Bell, Lewis and Yates mine, and by noon the work of rescue was well under way. The first attempt of a relief party to enter the mine was a failure, owing to large quantities of "after-damp." However, this failure did not deter the rescuers, and a second attempt was made, and the mine foreman and four other survivors, who had started into the south heading, were brought out alive, but suffering from the effects of the gas they had inhaled. Successive descents into the mine were made, and the bodies of the dead were brought to the surface. The interior of the mine on the north side is very badly wrecked, timbers smashed and rails twisted. The victims all met their death from the explosion. The cause of the explosion is, as yet, unknown, as all witnesses were killed. An inquiry and investigation will, however, be made, and it is to be hoped that the cause of the disaster will be discovered. It was the first serious explosion in the Dubois region.

Graphite Paint

There is on exhibition in the office of the Colliery Engineer and Metal Miner a piece of iron cut from a chimney formerly very rusty from exposure, but later protected by an application of the graphite paint made by the Detroit Graphite Manufacturing Company, which should be of interest to mine operators. This stack, as shown by the part impossible to reach at the time of the painting referred to, was very rusty when painted, and was considered, it is stated, to have at that time about outlived its usefulness.

After painting as above referred to, it served three years without further attention or repair, and was then only taken down to be replaced by a larger one necessary from the addition of more boilers to the power plant.

This paint has also proved itself of value in preventing corrosion and pitting of boilers from the effects of bad feed-water. In an experiment made in which a few tubes and a part of the inside surface of the shell of a return tubular boiler were painted, the balance of the exposed surface being left as ordinarily run, the paint was found to have had a wonderfully beneficial effect.

The address of the makers of this paint, whose advertisement appears for the first time in this issue, is 542 River Street, Detroit, Michigan.

Feed-Water Heating and Purifying Apparatus.

The above caption is the title of a pamphlet issued by Wm. Baragwanath & Son, 46 W. Division Street, Chicago, a copy of which should be in the hands of every mine operator and superintendent. In no industry are more serious problems encountered in keeping boilers in good condition than in mining, and in none is there greater importance of economy in the use of fuel, as trade conditions now exist.

This pamphlet, while put out in the interest of "Baragwanath" appliances, contains much matter worthy the careful attention of every steam user, showing as it does what economies can be effected by the use of improved and approved plant over that of less modern construction. Messrs. Baragwanath & Son make a full line of feed-water heaters, line steam purifiers, power boiler feed pumps, boiler cleaners and condensers. Their "Water Jacket Condenser" is shown in their advertisement.

Modern Methods of Mining and Handling Coal and Ore.

"Modern Methods of Mining and Handling Coal, Minerals, Etc." is the title of the Link-Belt Machinery Co.'s latest catalogue. It illustrates with fine engravings and descriptive texts, their electrical mining machinery, their elevating and conveying appliances, tipples, screens, etc., etc. It is a fine piece of typography, and should receive attention from the managers of all coal and ore mines. The apparatus and machinery described is all of the latest and most approved type, and every progressive mining man should familiarize himself with it. The catalogue is sent free on application to the Link-Belt Machinery Co., 39th St. and Stewart Ave., Chicago, Ill.

Steam Specialties.

No industry affords a larger and more profitable market for steam specialties than the mining business, and probably no makers of such goods are more favorably known to users than the International Specialty Co. of Detroit, Mich. The reputation of this firm has been built up on the Penberthy injector, but they make a general line of steam "brass goods" for nearly all purposes. The particular specialty they head their advertisement with in The Colliery Engineer and Metal Miner, is their "International" injector. We suggest that users of such goods provide themselves with this firm's catalogue, and keep it for reference whenever goods of this class are needed.

Air Compressors, Steam Pumps.

The Hall Steam Pump Co., of Pittsburg, Pa., begin with this issue of the Colliery Engineer and Metal Miner an advertisement of the machinery built by them. This company in addition to a full line of steam pumping machinery, is prepared to undertake the construction of air compressors of any desired capacity, the latter having been a specialty with them for some years past. On these two lines of machinery, both extensively used in the mining industry, the Hall Co., hopes for a share of the patronage of our readers.

Air Compressors.

Mr. Robert Laidlaw, president of the Laidlaw-Dunn-Gordon Co., of Cincinnati, Ohio, informs us that his company is doing quite a large business in air compressors, and especially in compressors for mining work. They have just furnished a large compressor to the Brown Mining Co., of Cardiff, Tenn.; and a pair of 20''x20''x36'' compressors with Corliss valve steam ends to W. J. Rainey, of Cleveland, Ohio, for use at his Mt. Braddock, Pa., coke plant.

Wages Advanced.

The following notice has been posted on the mine tipples of all the mines in the Clearfield, Beech Creek, Cambria and Gallitzin coal region: "On and after April 1 the employes of this company will be paid 45 cents per 2,240 pounds for mining. Day labor will be paid the same rates as when this price for mining formerly prevailed." The above notice means an advance to the miners of 5 cents per ton, or 12½ per cent. over the wages that have prevailed in the above named regions for the past two years.

Two Dead in a Mine.

Fire broke out in the Adrian No. 1 mine at Delaney, Jefferson county, Pa., March 23. Superintendent W. Robinson and five men entered to locate the fire and were overcome, but were rescued unconscious. A rescuing party was organized and Charles Lawrence, a track layer, and I. Jones, machinist, were found dead. Mr. Robinson and the other men will recover. The mine is owned by the Rochester and Pittsburg Coal and Iron Company.

Remarkable Escape of Eight Men.

Eight men narrowly escaped death at the main shaft of the Chicago and Minonk Coal and Tile Works at Minonk, Ill., on the morning of the 12th ult., through the breaking of a hoisting rope. The cage in which they were fell 555 feet. One man's legs were broken, and the other seven were badly bruised. How they escaped instant death is a mystery.

Mine Explosion Kills Two Men.

An explosion of fire damp occurred in the Ohio and Pennsylvania Coal mines at Port Royal, Pa., March 23, killing Alexander McDonald, the fire boss, aged 35, and William Davis, aged 15. The mine is about 200 feet deep, and the explosion shook the earth around the mouth of the mine. It was caused by the fire boss carrying a lamp into an unused part.

A Disastrous Explosion in a German Mine.

A cablegram from Berlin under date of the 4th ult., states that an explosion, followed by fire, occurred at Cleophas mine at Kattowitz, Prussian Gallicia, on that day, which resulted in the death of 60 miners.

BITUMINOUS STATISTICS FOR 1895.

In our last month's issue we published a summary of the statistics from the advance sheets of the reports of the inspectors of mines for the anthracite districts of Pennsylvania. The accompanying tables for the bituminous districts complete the coal statistics for the whole state for the year 1895. They were compiled from the advance reports of the inspectors by our special representative, Mr. Baird Halberstadt, mining engineer, Pottsville, Pa.

Table Showing Total Production, Shipments, the Increase in Production in 1895 Over That of 1894, The Total Production of Coke in 1895 and the Increase in Production Over That of 1894, Number of Employes, Fatal and Non-Fatal Accidents, Kegs of Powder Used, Number of Horses and Mules, Number of Steam Boilers, Tons of Coal Mined per Life Lost and per Non-Fatal Injury in the Bituminous Collieries of Pennsylvania in 1895.

Districts.	Total Production, tons (Short.)	Total Shipments, tons (Short.)	Increase in Production Over 1894.	Production of Coke. (Tons.)	Increase in Production of Coke Over 1894.	Number of Employes.	Number of Fatal Accidents.	Number of Non-Fatal Accidents.	Kegs of Powder Used.	Number of Horses and Mules.	Number of Steam Boilers.	Tonnage per Life Lost.	Tonnage per Non-Fatal Injury.
First	5,539,951	5,525,057	257,770	—	—	11,086	25	66	14,935	675	131	221,598	83,939
Second	9,128,787	5,140,140	2,704,154	2,569,085	965,842	11,865	32	55	371	1,013	241	285,274	165,978
Third	3,254,947	3,105,343	613,827		*3,488	6,211	7	23	18,249	498	49	464,992	141,519
Fourth	5,294,351	4,410,508	997,755	306,198	63,388	8,578	14	32	29,266	735	55	378,167	165,448
Fifth	6,423,892	959,364	2,515,456	3,756,487	1,491,516	8,389	13	70	6,150	719	192	494,145	91,768
Sixth	4,406,730	3,684,375	1,425,692	133,992	92,330	7,081	8	19	23,475	621	83	550,844	231,934
Seventh	4,693,508	4,439,405	454,683	5,000	*1,000	9,838	18	55	6,319	644	142	260,750	85,336
Eighth	4,709,962	4,608,287	1,255,854	24,180	10,858	8,071	13	34	18,537	849	104	362,302	138,527
Ninth	5,652,813	2,696,115	962,002	1,985,206	511,224	8,557	20	40	14,700	625	143	282,641	141,321
Tenth	2,708,271	2,485,246	825,741	142,221	94,435	5,098	5	25	17,066	481	54	541,654	108,331
Totals	51,813,112	37,125,840	12,012,902	8,902,329	3,223,085	84,904	155	419	149,268	6,060	1,247	† 421,630	† 123,659

Comparative Table For 1894.

Districts.	Total Production, tons (Short.)	Total Shipments, tons (Short.)	Increase in Production Over 1893.	Production of Coke. (Tons.)	Increase in Production of Coke Over 1893.	Number of Employes.	Number of Fatal Accidents.	Number of Non-Fatal Accidents.	Kegs of Powder Used.	Number of Horses and Mules.	Number of Steam Boilers.	Tonnage per Life Lost.	Tonnage per Non-Fatal Injury.
First	5,282,181	5,277,104	405,874	—	—	11,175	25	89	16,387	542	117	211,287	59,350
Second	6,424,633	4,000,777	*200,675	1,605,243	93,372	12,148	18	39	344	1,655	229	356,924	164,734
Third	2,641,120	2,619,382	*583,010	3,488	*23,551	6,734	9	12	9,401	405	64	293,458	220,093
Fourth	4,296,596	3,764,875	*555,525	282,810	*47,034	9,036	11	20	29,041	797	86	390,600	214,830
Fifth	3,908,348	929,701	278,789	2,264,971	171,978	7,619	13	47	3,835	619	185	300,642	83,156
Sixth	2,981,088	2,645,090	*139,196	41,662	*67,696	6,944	13	17	17,970	536	72	229,314	175,358
Seventh	4,238,825	4,002,534	*196,501	6,000	3,000	9,844	9	47	5,887	588	121	470,981	90,188
Eighth	3,454,078	3,382,396	*1,589,400	13,362	*37,555	8,399	11	41	12,423	837	100	314,007	84,245
Ninth	4,690,811	2,625,335	*123,967	1,473,982	233,818	9,270	11	40	11,145	533	132	426,437	117,270
Tenth	1,882,530	1,800,817	*880,586	47,786	*176,385	5,247	2	17	10,125	450	55	941,265	110,737
Totals	39,800,210	30,588,001	*3,021,688	5,680,244	149,947	86,177	122	329	116,558	6,382	1,150	† 326,231	† 107,890

*Decrease. †Average.

Table Showing Causes of Accidents, Number Attributable to Each, and Total Number of Fatal and Non-Fatal Accidents at the Bituminous Collieries of Pennsylvania in 1895 With a Comparative Table for 1894.

Causes of Accidents.	1st Dist. Fatal.	1st Dist. Non-Fatal.	2nd Dist. Fatal.	2nd Dist. Non-Fatal.	3rd Dist. Fatal.	3rd Dist. Non-Fatal.	4th Dist. Fatal.	4th Dist. Non-Fatal.	5th Dist. Fatal.	5th Dist. Non-Fatal.	6th Dist. Fatal.	6th Dist. Non-Fatal.	7th Dist. Fatal.	7th Dist. Non-Fatal.	8th Dist. Fatal.	8th Dist. Non-Fatal.	9th Dist. Fatal.	9th Dist. Non-Fatal.	10th Dist. Fatal.	10th Dist. Non-Fatal.	Totals. Fatal.	Totals. Non-Fatal.	Percentages. Fatal.	Percentages. Non-Fatal.
Explosions of Gas		5		2				2			1	3	2	5			1	1			4	18	2.58	4.30
Falls of roof, coal, slate, etc	20	43	21	32	4	13	10	20	4	31	5	8	12	31	11	24	13	21	4	18	104	241	67.09	57.51
Falling down slopes, shafts, etc									1												1		.65	
Explosions of powder, blasts, etc	1	1			1	3	1	1		3		1				1	1	1			4	11	2.58	2.62
Crushed by mine wagons, etc	3	12	7	17	2	7	3	9	6	24	2	7	3	18	2	6	3	17	1	6	32	123	20.64	29.36
Miscellaneous, underground	1	1	4	2						5						1				1	5	10	3.23	2.39
Miscellaneous, on surface		4		2					2	7			1	1		2	2				5	16	3.23	3.82
Totals	25	66	32	55	7	23	14	32	13	70	8	19	18	55	13	34	20	40	5	25	155	419	100.00	100.00

1894.

Causes of Accidents.	1st Dist. Fatal.	1st Dist. Non-Fatal.	2nd Dist. Fatal.	2nd Dist. Non-Fatal.	3rd Dist. Fatal.	3rd Dist. Non-Fatal.	4th Dist. Fatal.	4th Dist. Non-Fatal.	5th Dist. Fatal.	5th Dist. Non-Fatal.	6th Dist. Fatal.	6th Dist. Non-Fatal.	7th Dist. Fatal.	7th Dist. Non-Fatal.	8th Dist. Fatal.	8th Dist. Non-Fatal.	9th Dist. Fatal.	9th Dist. Non-Fatal.	10th Dist. Fatal.	10th Dist. Non-Fatal.	Totals. Fatal.	Totals. Non-Fatal.	Percentages. Fatal.	Percentages. Non-Fatal.
Explosions of Gas		6												3				8				17		4.61
Falls of roof, coal, etc	21	52	14	26	7	9	10	14	7	17	9	11	7	31	6	24	9	20	1	9	91	216	74.59	58.54
Falling down slopes, etc									2		1										3		2.46	
Explosions of powder, blasts, etc	1	3				2			1						1			5		2	3	12	2.46	3.25
Crushed by mine wagons, machinery, etc	1	19	4	10	1	1	1	5	3	23	3	6	1	7	4	13	2	7	1	6	21	97	17.21	26.28
Miscellaneous, underground	2	9		3	1			1		7			1			3					4	27	3.28	7.32
Miscellaneous, on surface														3		1								
Totals	25	89	18	39	9	12	11	20	13	47	13	17	9	47	11	41	11	40	2	17	122	369	100.00	100.00

Opening a New Coal Tract.

Contractor Edward Askew, of Mt. Carmel, with a force of men, recently began opening up the Germantown coal tract, northwest of Ashland, for the Lehigh Valley Coal Company, and the work will be pushed ahead as rapidly as possible. The scene of operations is at the base of the Locust mountain, north of Nineteenth street in this borough. Lewis A. Riley & Co., opened up a slope there some time ago, but did not prosecute the work very far, as about the time they had the work begun, the negotiations that finally resulted in the transfer of the coal tract to the Lehigh Valley Coal Company began. The deal was completed a few weeks ago as was fully told in this paper, at the time, as was also the fact that this tract would be developed, and the other incidental points connected with the work. The new breaker that will be erected by the Lehigh Valley Coal Company will be situated on the flat near where operations have been begun. The site is admirably situated, and no better location for a breaker could be desired. There is ample room for culm, and good location for all the side tracking necessary. The breaker will be a model one in every respect, and will be fully equipped with all the latest coal cleaning appliances. It is expected to give employment to from 700 to 1,000 men and boys, and will be the means of greatly increasing Ashland's population. Before very much of this work can be done it will be necessary to get the branch of the Lehigh Valley railroad tracks built into the tract, and preparations are being made to push this work ahead. The engineers have begun work and have run the preliminary lines from North Ashland, where the main line connections will be made, to the site of the new breaker. It will take a week or two to complete the lines, to do which the work of survey will be pushed ahead with all speed, as it will be necessary to open up before the material can be taken to the grounds.—*Evening Telegram, Ashland.*

New Engineering Offices.

On March 1st Messrs. A. B. Cochran & Son, civil and mining engineers, of Pottsville, removed from their former offices in the Evans building to the new fireproof Smith building recently completed. The Messrs. Cochran occupy the entire second and third floors of the building, consisting of two suites of four rooms each. On the second floor front are the private offices of the firm, a toilet and map room. A fire-proof map vault will be built on the rear of this room. A very handsome map case of polished oak for blue prints and tracings has been erected in the map room. On the third floor are three draughting rooms and a second toilet room. A light well affords ample light to the interior rooms. The building is heated by steam, and all the rooms are fitted with combined electric and gas chandeliers. The arrangement of the rooms is excellent, and no handsomer or more commodious engineering rooms can be found anywhere in the anthracite region. The Messrs. Cochran employ nine engineers and draughtsmen.

Packing.

We are in receipt of a communication from the Garlock Packing Co., of Palmyra, N. Y., and Rome, Ga., that reports a large increase in their business during the past few months. This increase necessitated running their factories over time, and as the demand for their product continues to increase, they have begun the erection of a large addition to their Palmyra, N. Y., plant. This enterprising company has branch offices in New York, Boston, Chicago, Philadelphia, Pittsburg, St. Louis and Omaha.

The Girard estate asked for proposals for the construction of a large reservoir upon its lands, on Locust mountain, near Raven's Run, Schuylkill Co. Bids have been received by Major Thompson, the engineer, from Messrs. M. P. Quinn, Lewis Grant, Thos. H. Rickert, Chas. F. King and P. McManus.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

GEOLOGY OF COAL.

Ruptures in the Earth's Crust—The Effects of Eruptive Dykes.

58. **Ruptures in the Earth's Crust.**—Great fissures are sometimes met with in mining that are known to be of depths reaching from the surface of the earth to its heated and plastic interior.

These great cracks are filled with a hard flinty stone that has been injected in a state of fusion, and they are now known by such names as whin dykes, igneous dykes, lava dykes and elvan courses. They are correctly called dykes, because they are partitions that completely cut off the contact of the same ruptured beds on one side of them from those on the other.

These dykes seldom dislocate the levels of the fractured rocks, and yet they are always found passing through or running along the flanks of highly convulsed regions, where the strata have not only been upheaved, but broken and disjointed with great faults.

Many of these extraordinary lava dykes were injected during the periods of the deposition of the Carboniferous and Permian series of rocks, for we find their tops passing through the lower or older series, and overlaid with the newer or later series of the same formations. To sustain the interest that is required for making a close acquaintance with the part these intruding igneous rocks have played, in placing within the reach of man minerals and metallic ores, that could not otherwise have been accessible, we introduce Figure 94 and this will give the right cue to understand the character of these vertical sheets of igneous rock that lodge within the great planes of fracture, and are now known as dykes. In the figure a dyke is shown partly in plan

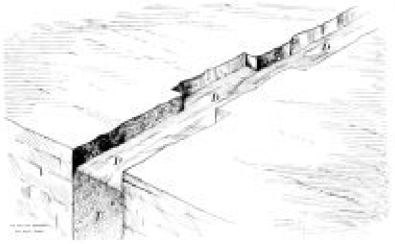


Fig. 94.

and partly in vertical section, and it is intended to represent the filling in of the fracture just after the injection of the fused rock, and at *D*, *D*, *D*, we are supposed to see the surface of the lava stream, while at *T* we see the upper portion of a vertical section that is passing down into the earth's crust.

The figure, however, only conveys to the mind a very finite idea of the longitudinal extent of these far reaching cracks that course, in some cases, for *hundreds* of miles through a vast region, and they are found all over the world where there are good, productive, metalliferous fields.

We cannot for one moment think of the enormous strain to which the shell or crust of the earth has been subject when it cracked right through to its molten kernel to produce these lava dykes, and not at the same time see that other contemporaneous cracks would be produced, accompanied with considerable sliding and disjointing of the strata, and thus providing spaces through which would upflow, for very long periods of time, boiling streams of water. We can see then that the forces that have broken the earth's crust, and filled many of the deep, penetrating and yawning cracks with molten rock, have been most generous to man in placing within his reach vast supplies of metalliferous and native metals, and yet as a general rule the ores are not often found in the lava dykes, but in the veins in their vicinity, for we now know that the boiling streams to which we have just referred were the carriers of the metals and other minerals into the fissures that are now known as metalliferous lodes. We see then that the earth's nether fires increased the solvent power of the water, and hence it acted selectively in percolating through the interstices of the rocks, and cumulatively made large deposits from infinitely small sources. The periods during which many of the lava dykes were formed are well known, and indeed they cannot be mistaken, for the tops of many of them are found to terminate in rocks of the Carboniferous and Permian ages, as has been noticed. The Permian period was one of great volcanic action but the period of the lower coal measures was more extensively so, for then, not only did the lava fill the gaping dykes, but it overflowed extensive areas of the sea floor, and wide spreading areas of dry land as lava sheets or "whin sills," and in some cases the molten stony fluid has been ejected with force sufficient to lift the overlying strata and insert itself between the bedding planes of coal measure strata as shown by Fig. 95, where a vertical section of a dyke is shown at *D*, and the intruding shelves are shown at *I* and *I* where they are seen to have crushed and broken a bed of shale *S*, *S*, but immediately after the upflow of the dyke, and during a succeeding period of repose, a later stratum is seen to have been deposited at *L*, *L*. Now what the miner must be careful to notice is this, the eruptive dykes are the constant accompaniment of veins whether productive or not, for the rocks may be so compact, dense and close that the ejected hot water cannot percolate through them, and therefore veins in them are always barren. On the other hand, loose conglomerates, breccias and open, gritty sandstones are often the seats of true segregations, and all the world over we find that under like

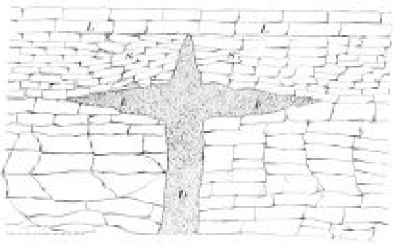


Fig. 95.

conditions the same results occur; for example, gash or true veins in limestones or shales frequently contain the ores of lead and silver, and when they do the ores are always richer in silver when the vein cuts through shales than when it cuts through limestones. We can, however, only rely on these occurrences for specific shales and specific limestones, for many shales and many limestones are not ore producing, because the conditions of location have not been favorable for the segregation of ore; for example, if during the filling of the vein the temperature of water injected into, and ejected out of, the vein has not been that best adapted, or if certain bodies are absent from the waters, that would act as powerful solvents when present, then the poverty of the vein is accounted for. Our subject, however, is dykes, and we are in this lesson more concerned about their effects on coal and coal-bearing strata, but before dismissing the question of the relation of dykes to metalliferous veins, let us notice a great fact that will collaterally concern us in relation to the great coal fields of the world.

59. **The Effects of Eruptive Dykes.**—In the United States the ore-bearing regions of value are always found in the neighborhood of great eruptive dykes, and such are those of Georgetown and Leadville, Colorado. We see, then, that the collection and concentration of metallic ores has been done largely by the agency of hot springs, and that we owe to the fires of the earth, directly and indirectly, not only the selection and collection of the ores, but the making of the great cracks in

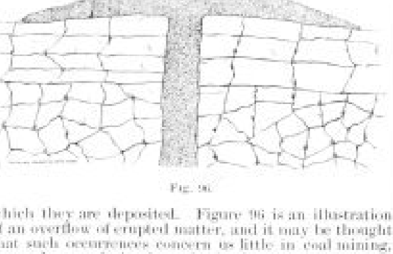


Fig. 96.

which they are deposited. Figure 96 is an illustration of an overflow of erupted matter, and it may be thought that such occurrences concern us little in coal mining, but such a conclusion is a mistake, because in some coal fields these dykes not only cut through the coal measures and completely separate one portion of the field from the other, but they have injured the coal by coking it, and have made barriers that are costly to drift through. Again, in the vicinity of the dykes the most serious interruptions in the coal seams occur, with all the consequent difficulty and expense in mining, and yet we now know that where the strata is not crumpled up, or cut through with faults and dykes, coal is never found, for it has only been preserved by gradual submergence in water where it was covered up with some protecting strata and then upraised by the same forces that depressed it, and produced the dykes and great faults, behind which it is sheltered from destruction. We see, then, that beyond all question, the eruptive dykes, if not a cause, are at any rate one of the results of a cause that has collected our valuable minerals in veins, and has preserved our coal seams, submerged them, covered them, upraised them, and sheltered them, and made them accessible for mining. The great canyons of

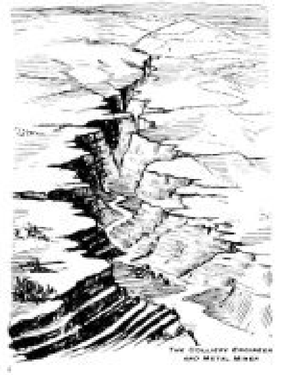


Fig. 97.

Colorado are like great fissures and really resemble them, but are now admitted to be the work of erosion by water. Figure 97 is a view of a canyon cut in marble, and it is a portion of the Colorado river and is here only introduced to furnish to the reader an idea of one of these huge cracks. The dykes are in many cases as wide as the Colorado river, although some are only six feet thick, and in length they far outrival the river, as some of them are of unknown lengths, although their course has been followed for hundreds of miles.

Recapitulation Questions.

QUES. 1. What are the names common to igneous dykes?

ANS. The igneous dykes are called whin dykes, elvan courses, lava dykes, porphyritic dykes, and dykes.

QUES. 2. Do dykes always dislocate the rocks they pass through?

ANS. Dykes seldom dislocate the rocks they pass through.

QUES. 3. In what regions are dykes chiefly found?

ANS. Dykes are always found in regions that have been subjected to great convulsive action where the disturbing forces have crumpled up the stratified and unstratified rocks and disjointed them with great faults.

QUES. 4. Can we in any way correlate the ages of these dykes, or name the periods in which they were formed?

ANS. The relative ages of the dykes or the periods during which they were formed can be fixed with great certainty, for during the Carboniferous and Permian periods the tops of some of these dykes are found to have penetrated up through the lower series of the rocks, while their tops are covered with the upper members of the series, thus proving conclusively that the cracks were made and the molten matter injected during the periods of the deposition of the rocks in which they are found.

QUES. 5. Have these dykes done any good service to mankind?

ANS. We cannot doubt the conclusion that these dykes have done good service to man, for even now their presence is a sure indication of a convulsed region where productive veins may be found; and where the dykes were formed they acted as the main channels for the ejection of hot water and steam into the collateral cracks that became the productive veins.

QUES. 6. Has the outflow of igneous rock from dykes ever exceeded the outflow from the funnels of volcanoes?

ANS. The outflow of igneous rock from dykes has far exceeded the outflow from volcanoes, for the lava sheets, that have intruded between the stratified rocks and overflown the sea floor and the dry land surface, furnish examples of rock masses far in excess of the masses due to the outpourings of volcanoes.

QUES. 7. Were jointed or close and unfractured rocks the most likely receptacles for the injected ores during the period of thermal activity in a region?

ANS. Soft, jointed, and porous rocks, such as conglomerates, breccias and gritty sandstones, were highly favorable receptacles for some kinds of metals that were so combined as to be soluble in the hot waters circulating through the interstices of these porous rocks.

QUES. 8. Are the ore-bearing regions of the United States the seats of porphyritic dykes and trap or lava sheets?

ANS. The ore-bearing regions of Georgetown and Leadville, Colorado, are the seats of porphyritic dykes and immense sheets of trap rock, and the same igneous rocks are found in all the productive ore-bearing regions of the United States.

QUES. 9. What effects have the intrusions of igneous dykes had on the coal seams, where the dykes were formed after the coal measure strata?

ANS. Where the igneous dykes have cut through the coal seams, the coal is burned into ash at the junction, and farther from the dyke the bituminous coals are coked, and also in the regions of such dykes, the coal seams are dislocated with great faults.

QUES. 10. Have faults been favorable or unfavorable to the preservation of the coal seams?

ANS. Faults have been favorable to the preservation of the coal seams, and we find, therefore, that the coal measure strata that have remained unaffected by the agencies of destruction and waste, have been preserved in the troughs or depressions between two or more great rock waves, or have been saved by the shelter afforded in the depressed sides of great faults.

(To be Continued.)

CHEMISTRY OF MINING.

Different Forms of Safety Lamp Glasses—The Dimensions of Lamp Glasses—The Surfaces of Glasses. Effects of Hot Glass on Light—Recapitulation of Facts.

96. **Different Forms of Safety Lamp Glasses.**—Many singular shapes have been given to the glasses of safety lamps, but none of them have survived the tests of actual use, consequently the old cylindrical glass is still the first favorite. When Mr. Silas Lever offered a reward for the best safety lamp for use in mines, the patent offices of all the great mining countries of the world were flooded with applications for the protection of the novel inventions of a mighty host of otherwise clever men, and yet this great multitude have since settled down in silence without even so much as having secured an undisputed claim to one new departure in lamp construction, and the result is, the safety lamp is not improved, nor will it ever be, by simply trying to reform the lamp as it is. What we require, then, is not so much the power of mechanical resource as the power of self-reliance to cast off the present mode of construction and contrive a new one from the teachings of knowledge, calculation and experience. We are not trying in this lesson to determine what should be the finality of construction for any of the parts of a safety lamp, but to show the lines along which we must travel to secure the best facts for the best results.

So far as the shapes of the glasses are concerned, crank shaped, frustum shaped and spherical shaped have

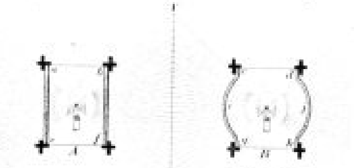


FIG. 134.

all been tried as successful rivals of the cylindrical shape, and yet the latter endures for reasons that will now engage our attention. Fig. 134 illustrates a test of a bulging glass *B*, against a cylindrical glass *A*, for diffusion; and it will be seen that the figure of the bulging glass does not give it any advantage over *A*, because the refraction due to the spherical form is so small that it may be disregarded, for when the glass is relatively thin, and the inside is parallel to the outside, it is no better, but worse, as a transmitter and diffuser of light; for be it observed that where the area of the surface of the glass is increased, the light meets with an increased resistance that is due to the passage of the same bundle of rays through a greater mass of glass. These facts are manifest when we observe that the angle of diffusion is the same for the spherical as for the cylindrical glass, for the center of the flame in *A* is at the same distance as the center of the flame in *B* from the vertical line *V T*, and as the top and bottom diameters of the two glasses are equal, that is, *a b* is equal to *c d* and *e f* is equal to *g h*, the angles of diffusion are also equal. That is to say, the chords of the angles of diffusion in the two cases are equal to *V T*. From all this we learn two things, and the first is: Before we can design a glass for a safety lamp on correct principles, we must be sure that the form and dimensions harmonize with the requirements of the laws of light. Second, when law is disregarded, fancy glasses are fruitful sources of disappointment.

97. **The Dimensions of Lamp Glasses.**—It is no easy matter to determine the form and dimensions of a lamp glass, for in no appliance are the ruling principles more seductive and misleading when *separately* considered; and with the view of pointing out how false conclusions may be arrived at, Fig. 135 is introduced. Here we have gas jets burning in the globes *G* and *g*, and if we take the jets to be of equal potential, or illuminating power, the light emitted from the glass globe *g* ought to be more powerful than that given

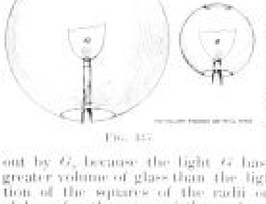


FIG. 135.

out by *G*, because the light *G* has to pass through a greater volume of glass than the light *g*, in the proportion of the squares of the radii or diameters of the globes; for the areas of the surfaces of globes vary as the squares of their diameters, when the thicknesses of the glass shells are equal. Then, if the diameter of the globe *G* is 6 inches and that of *g* is 3 inches, we find the resistance the light meets with in passing through *G* is 4 times that to be overcome in passing through *g*, for $\frac{6^2}{3^2} = 4$. We must, however, see, that the power or potential of the light will be inversely as the resistance, therefore the illuminating power of two equal gas jets, after the light has been passed through the shells of unequal spheres, will be for the large shell $\frac{d^2}{D^2} = p$, *p* being the effective potential of the light. Now, as the word potential may here perplex and not assist some of the readers, let us discover and explain its *factors* or *makers*. To find the potential of a light two factors must be known, and they are the *volume* and the *tension*, or intensity, of the light. For example, suppose the globe *G* in the figure to be a volume of flame, or matter in a state of incandescence, and the small globe *g* to be the same, then to make the potentials of the two lights equal, that is, their power to fill equal spaces with equal light, the tension or intensity of the light *g* would have to be 8 times that of *G*, because the volume of *G* is 8 times that of *g*, or $\frac{6^3}{3^3} = 8$; or let the large volume equal *V*, and the small one equal *v*, and the high tension equal *T* and the low tension equal *t*, then in this case the equal potentials would arise in this way, $V t = v T$, or $8 \times 1 = 1 \times 8$. We see, then, that the potential of a light is the product of its volume into its intensity. All have noticed that a very small candle illuminates a much smaller space than a

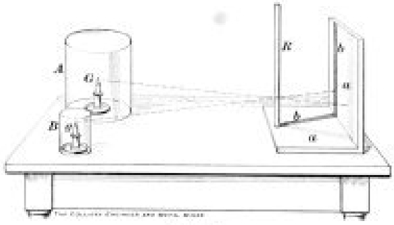


FIG. 136.

large one; that is to say, a small light fills a less space than a large one when their intensities are equal, and the intensities of the candle lights are supposed to be equal, for if the volume of the large light is eight times that of the small one, then the large one will fill with light a space eight times as large.

Again, suppose the large volume of light to come from a mass of red-hot iron, and the small volume of light to come from the flame of a kerosene lamp, and let the intensity of the light from the hot iron be equal to 1 and the intensity of the light of the lamp be 3,000 and the volume of the hot iron be 30 and that of the lamp flame be 1, then the light from the red-hot iron will only have an illuminating potential of the one-hundredth that of the lamp flame, for $\frac{30 \times 1}{1 \times 3{,}000} = \frac{1}{100}$. We now see the importance of the meaning and relative value of the terms volume, tension and potential. Next let us consider the relative resistances that lights are subject to in transmission through glasses of the same thickness but different areas of shell surface, and to assist in the investigation Fig. 136 is introduced.

98. **The Surfaces of Glasses.**—Would any one who had not tried the experiment suppose that the magnitude of the glass shell that encloses a light-giving flame would affect the potential of the light so much? In the figure, two candles of equal potential are set within the glass cylinders *G* and *g* to test the effect of increased resistance to the light passing through the large cylinder *G*. It will be seen that *G* is double the diameter of *g*, but there is another qualification in the dimensions of these cylinders that requires close attention, and that is their lengths, and be it observed that if *g* had been the same in length as *G* the photometric measurement of the lights would not have shown the shadow *b* to be so deep in tone in contrast with *a*, for the increased length of the narrow glass *g* would result in the cylinder being heated and as hot glass offers a greater resistance to the transmission of light than a cold one, the reason for the conclusion that a long glass would introduce a new resistance is at once seen, for the position of the flame in *g* is such that the heated gases ascend at once out of it, while the cold air in descending cools the otherwise exposed glass around the flame. We see then that the glass shells *A* and *B* are unequal while the lights *G* and *g* are equal and we now discover that, so far as the diameters of the cylinders are concerned, if their *temperatures* are equal, the effective potentials of the lights will vary inversely as the squares of the diameters of the cylinders. Hence the shadow of the rod *R*, cast on the back screen at *a a*, is scarcely visible beside the deep dark shadow cast by *g* on the back screen at *b b*. Here then if the temperatures of the glasses are equal the resistances to the passage of the lights will vary *directly* as the squares of the diameters of the cylinders, and therefore the resistances and potentials are the inverse of each other; for, let *r* stand for the resistance and *p* for potential, and *D* for the large and *d* for the small diameters, then $\frac{D^2}{d^2} = r$ for the large cylinder, and $\frac{d^2}{D^2} = p$ for the large cylinder, or for the small cylinder $\frac{d^2}{D^2} = r$, and $\frac{D^2}{d^2} = p$.

98. **Effects of Hot Glass on Light.**—If two kerosene lamps of equal illuminating potential are taken, some very interesting experiments can be tried. The reader will have found by observation that the biggest flame in a lamp does not supply the most satisfying light, for two reasons, first the combustion is not so complete in the large as in the small flame, and second the larger flame raises the glass chimney to a higher temperature and thus introduces a higher resistance to the passage of the light, and but for the elongation of the larger flame, that increases the volume of the light, the smaller light would far exceed in potential the larger one. These facts can be shown by the contrasted shadows as in Fig. 137. Here the cool glass that encloses the light *A* casts a shadow of deeper tone as *a a*, on the back screen,

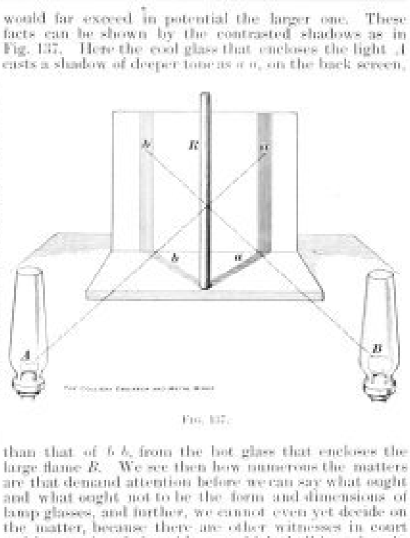


FIG. 137.

than that of *b b*, from the hot glass that encloses the large flame *B*. We see then how numerous the matters are that demand attention before we can say what ought and what ought not to be the form and dimensions of lamp glasses, and further, we cannot even yet decide on the matter, because there are other witnesses in court waiting to give their evidence, which shall be taken in the next lesson; and before we further proceed, let us observe that the early inventors of the safety-lamp were more concerned about a "convenient size of the lamp glass" than about how the different dimensions of the glasses would affect the transmission and diffusion of light, and strange to say the glass cylinders of the modern lamps are after all only copies of the early Clanny lamp, as illustrated by Fig. 138, at *G* and it will be seen by the directions of the descending and ascending arrows within the glass that so far as cooling was concerned the provision had been made, yet as the supply of fresh air was through the meshes at the lower end of the gauze tube, this air could not descend without receiving some heat by radiation.

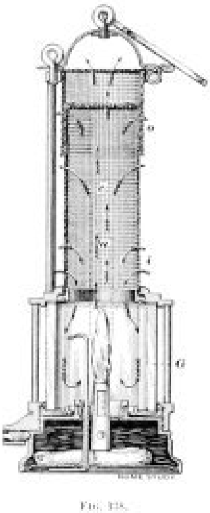


FIG. 138.

The Clanny lamp, however, is the parent of all the succeeding lamps that have been fitted with a glass cylinder and it remains until now very little improved.

99. **Recapitulation of Facts.**—QUES. 1. Would a bulging or spherical shaped glass give better results in diffusing the light of a safety-lamp than a cylindrical one?

ANS. A bulging or spherical glass in a safety-lamp does not increase the angle of diffusion when the top and bottom diameters and the lengths are the same as those of a cylindrical glass.

QUES. 2. Is the effective potential of the light from a bulging glass equal to that from a cylindrical one?

ANS. As the increased area of the surface of the shell of a bulging glass is greater than that of a cylindrical one whose top and bottom diameters and length are the same as those of the bulging one, the spherical glass introduces a greater resistances to the passage of the light and therefore reduces the effective potential.

QUES. 3. What principles should guide you in determining the correct form and dimensions of the glass of a safety-lamp?

ANS. To secure the greatest efficiency in illuminating power, the form and dimensions of the glass should harmonize with the requirements of the laws of light.

QUES. 4. What are the factors or makers of the potential of light?

ANS. The power or potential of light is the product of its two factors, namely the volume of the light, and the intensity of the light; for the volume of a light may be as small as the head of a pin on the one hand, and as large as a two inch globe on the other, and if their intensities are equal the large volume will illuminate a large space while the small one will illuminate a relatively small one, because their *filling* powers are proportionate to their volumes when the intensities of the lights are equal. To make the potentials of the two lights equal, the intensity of the small volume must as far exceed that of the large one, as the large volume is greater than the small one, or to make the matter clear let *I* equal the high intensity, and *i* the low one, and *V* the large volume and *v* the small one, then $v I = V i$.

QUES. 5. How does heat affect the transmission of light through glass?

ANS. When glass shells are set over illuminating flames the hot glass medium introduces a greater resistance than a relatively cold one and therefore the potential of the light from a cold glass is greater than that from a hot one.

QUES. 6. Give from nature an example of a large volume of light with a low intensity?

ANS. The volume of the light of the full moon is sufficient to illuminate half the surface of the earth, while its intensity is so low that if a pencil of its rays are admitted into a dark room through a hole about the size of a candle flame, the light giving power of this restricted beam is so small that it does not give sufficient light to enable one man to see another.

QUES. 7. Give from nature an example of a light that is at once great in volume and high in intensity?

ANS. The light in nature that is great in volume and high in intensity is the sun.

(To be Continued.)

MINING MACHINERY.

Pump Movements and Resistances—The Sizes of Pump Valves—The "Tail" or Suction-Pipes of Pumps—Recapitulation of Facts.

109. Pump Movements and Resistances.—Mining students know the fact, intimately, that the resistances due to the motions of fluids vary as the squares of their velocities through orifices, and this being the case, we can understand how a high resistance is produced by a high velocity of the fluid at the port of entry, and how by this means the working efficiency of a pump is sometimes reduced.

The constriction or contraction at the entrance into the piston chamber of a pump may be caused, as it often is, by the valve orifice being too small. Mistakes of this kind are frequently met with, and they often arise from misconceptions of common causes; for example, what is called a one-inch faucet would be used to discharge water from a one-inch pipe, but on inspection it is found that the water-way or hole through the tap or shut-off plug only has a mean diameter of half an inch, or an area one-fourth that of the section of the pipe; and strange as it may appear, the water-way of the plug is large enough, because it can discharge at a velocity nearly equal to that at which the water can flow through the *length* of the pipe. It is therefore concluded that as a small water-way at the point of discharge is nearly as efficient as one having an area equal to that of the section of the pipe, the area of the water-way of the suction valve, or the area of the transverse section of the suction pipe of a pump, need not be more than a third or a fourth of that of the piston. The pump and the faucet are not, however, alike either in the discharge or the outflow, for we can lengthen to any extent the head of flow, which means that we can increase the length of the motive column to obtain pressures of more atmospheres than one, but we cannot obtain more than a vacuum under the piston of a pump, and if the suction pipe is any length at all, we never can get a pressure equal to that of the atmosphere to inject the entering water. Theoretically the pressure of injection varies as follows: Let a vertical column of water have a length of 34 feet to balance the pressure of the atmosphere, and let us represent this 34 by H, and let us use h to represent the height in feet the pump piston is situated above the level of the water to be pumped, then if the pressure of the atmosphere is equal to 2,125 pounds per square foot at the base of the column, the theoretical pressure of injection will be $\frac{(H-h)\,2{,}125}{H} = p$, and to give the matter a realistic character let us suppose that the pump piston is 16 feet above the intake water, then $\frac{(34-16)\times 2{,}125}{34} = 1{,}125$, equal the pressure per square foot producing injection. The number 2,125 pounds per square foot that balances the pressure of the atmosphere is found as follows: A cubic foot of water weighs 62.5 pounds, that is, mine water, for *pure* water weighs a little less; then 34 cubic feet set one over the other must weigh, as a column, $62.5 \times 34 = 2{,}125$ pounds. Again, let us notice that the pressure of the atmosphere in a deep mine is greater than at the surface, and therefore it sometimes requires at the bottom of a shaft a column of 37 feet to balance the atmospheric pressure, and as the barometer fluctuates in height at the surface of the sea, we sometimes find it so low that a column of 31 feet of water will balance it. Again, at high elevations in mountain regions the pressure may be as low as the equivalent of a column of 20 feet of water, and from the statement of these facts we learn that H varies so much in value that 2,118, or in the case before us, 2,125, cannot be taken as any other than average atmospheric pressures at the level of the sea. Let us next notice that the theoretical value of $\frac{(H-h)\,2{,}125}{H} = p$ is never true in practice, nor can it be, for water cannot move without meeting with resistance. It is nearer the truth of actual practice, then, to say $\frac{(H-h)\,2{,}125}{(H+h)} = p$, and therefore when h is equal to 16 we have $\frac{(34-16)\times 2{,}125}{(34+16)} = \frac{18 \times 2{,}125}{50} = 762$ pounds, the pressure of injection at the bottom end of the suction pipe, or "tail" of a pump. Again, let us observe that the *square* of the velocity in feet per second of water rushing into a vacuum, when propelled in doing so by the pressure of the atmosphere, is 2,180; then the velocity of the water, in feet per second, rushing into the piston chamber, when h is equal to 16, will be $\sqrt{\frac{(34-16)\times 2{,}180}{(34+16)}} = 28$, the velocity of the water in feet per second entering the pump. This conclusion is based on the law in mechanics that the pressures in relation to fluid movements vary as the squares of their velocities, therefore, in the case of water moving into a depression, the square 2,180 varies as $\frac{(H-h)}{(H+h)}$ varies. We are now in a position to resume the investigation of the effects of the constrictions of the water-ways through valves as affecting the efficient action of pumps; and let us lead off with the supposition that the available water-way through the orifice of a suction valve is only one-fourth of the area of the pump piston as shown by Fig. 143, where P is the pump piston and $b\ p$ is the available orifice of the valve, and the arrows are here given to indicate the acceleration of the fluid movement due to the small area through the valve.

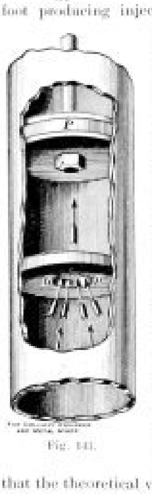


Fig. 141.

110. The Sizes of Pump Valves.—Now if the area of the water way through the valve at $b\ p$ is one-fourth of the area of the piston, we can see that the speed of the piston must be reduced to one-fourth, or otherwise the engine must advance the pump piston beyond the reach of the inflowing water because the inflow cannot take place at a higher velocity than the available pressure can maintain, then let us take h again at 16, then $\sqrt{\frac{(34-16)\times 2180}{(34+16)}} = 28$, but whether the area of the orifice be large or small, if the effective pressure remains unaltered, the velocity will be in all cases the same, therefore at equal velocities only one-fourth of the volume of the water will flow through the small orifice that would upflow and fill the pump cylinder if the channel was unobstructed, or in other words, to make the matter plain, if the orifice through the valve is one-fourth the area of the piston and if the piston is moving with a velocity of $28 \times 60 = 1680$ feet per minute, then the pump cylinder will only be one-fourth full every time the piston reaches the top of its stroke because $\frac{28}{4} = 7$; that is, only one-fourth of the water required to fill the cylinder could enter at a velocity of 7 feet per second. It might be inferred from these conclusions that if the engine or the pump piston was run at one-fourth of the speed of 1680 feet per minute that even with the small water way through the valve no loss of mechanical effect would then occur, but such is not the case, because the depression for quarter speed would have to be the same as for full speed, or the force to move the piston would be the same in both cases because both speeds require a vacuum under the piston. We see then that from every point of view it is important to have the water-way through the suction valve sufficiently large to keep the velocity of the fluid as nearly as possible equal to the speed of the piston of the pump. Fig. 144 deals with the suction pipe $V\ T$.

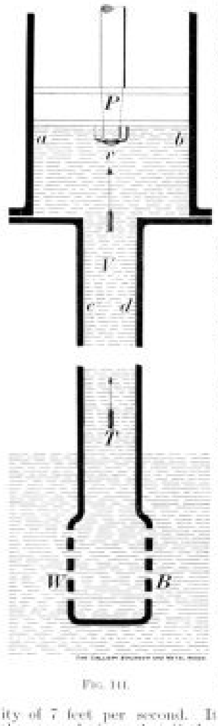


Fig. 144.

111. The "Tail" or Suction Pipes of Pumps.—Perhaps the best object lessons men get are those taught them by mistakes or gross errors that are highly magnified, and the figure before us is of the type of a "gross error magnified." The instinct of a man of any mechanical intuition would shudder at the thought of a tail pipe of a pump being only one-third of the diameter, inside measure, of the pump piston, or the area of $c\ d$ one-ninth that of $a\ b$, or that when the pump is in action, the velocity of the water in the tail pipe at V is nine times greater than the water under the piston at v, for the velocities are inversely as the squares of the diameters, or inversely as the areas; again, just fancy the velocity through the holes in the strainer $W\ B$, and especially if the joint area of the holes is less than the the area of T, and here is enough to magnify the gross error of making the tail pipes of a pump too small. Now taking h at 16 again,

$$\sqrt{\frac{(34-16)\times 2180}{(34+16)}} = 28 \text{ nearly,}$$

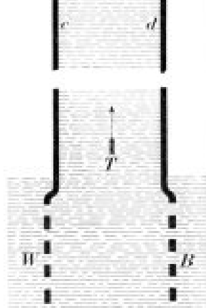


Fig. 145.

but the velocities of the water in the cylinder and tail pipe are inversely as their areas or if v is 1, V is 9, then $\frac{28}{9} = 3+$ and if the joint area of the strainer holes is one-fourth that of $a\ b$, then to entirely fill the cylinder at every stroke the speed of the piston would have to be reduced from 1648 per minute to $\frac{1648}{16} = 103$. It might be thought that a little reduction in the size of the tail pipe would have little effect on the efficiency of the action of the pump, but we must first understand what we mean by efficiency. Well, we mean the pump that will lift the volume of water required per minute with the smallest possible expenditure of energy. Just so, then let us apply this claim to Fig. 145, and let $c\ d$ be two-thirds the diameter $a\ b$, then the velocity of the piston being $v = 4$, that in the tail pipe at V will be 9, but if the joint area of the holes in the strainer or wind-bore $W\ B$ is ¼ of the area of the pump piston P, then, if the velocity of the piston is 4, that of the water entering the holes in the wind-bore will be 25 or 6.25 times the velocity of the piston, or this constriction would reduce the effective piston speed to 4.48 feet per second, because $\frac{28}{6.25} = 4.48$. On every hand then we are checkmated where the joint area of the holes in the wind-bore is too small, or where the area of the tail pipe is too small, or where the waterway through the suction valve is too small. Let us next consider then the results of introducing another "magnified gross error." Fig. 146 is an example wherein the tail pipe is too large, for if the diameter of the piston P or $a\ b$ is 2 and that of the tail pipe T or $c\ d$ is 3, then the velocity of the water advancing up the tail pipe will be 4/9ths that of the piston and, leaving out of the question the joint area of the holes in the wind-bore, we cannot but be satisfied that by this scheme any abnormal resistance is removed from the ports of entry into the pump cylinder, but to introduce such a tail pipe would be in keeping with the conclusion that if the frictional resistance due to the axle of a small wheel was greater than that due to a large one, it would be wise to fix 20-foot wheels on a buggy; now such a wheel would have to be very much heavier than a four-foot wheel, and therefore it would most likely increase the resistance more by its weight than it would reduce it by its decreased angular velocity; besides the large wheel would cause a needless shake and it would be subject momentarily to a break down. So with a large tail pipe we would be confronted with new troubles, for all water contains air in solution that is set free in a vacuum, and we would soon have a collection of air that would render the pump with the overdone tail pipe perfectly wasteful, even more so than in some cases where the tail pipe is too small; and therefore, to provide for the dislodgment of air and yet not to accelerate too much the velocity of the water in the tail pipe, it has been found by practice and experience that the best results are obtained when the diameters of the tail pipe and piston are to each other as 9 is to 10, or when the diameter of the tail pipe is .9 of the diameter of the pump piston.

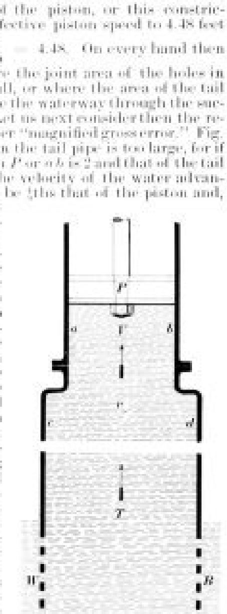


Fig. 146.

112. Recapitulation of Facts.—QUES. 1. Express for me the laws of pressure and resistance in relation to the motion of fluids.

ANS. The pressures required to set fluids in motion from a state of rest vary as the squares of the velocities of the fluid streams, or the reverse is equally true, and that is, the velocities vary as the square roots of the pressures.

Again, the resistances vary as the squares of the velocities, but the velocities vary as the square roots of the resistances inversely; for example, let v equal the velocity, and p equal the pressure, and r equal the resistance, and we can show that: The pressures vary as the squares of the velocities, as $v^2 = p$.

The velocities vary as the square roots of the pressures, as $\sqrt{p} = v$.

The resistances vary as the squares of the velocities, as $v^2 = r$.

The velocities vary as the square roots of the resistances inversely, as $\sqrt{\frac{1}{r}} = v$.

QUES. 2. If a vertical column of water, 34 feet high, balances the pressure of the atmosphere, what is that pressure in pounds per square foot?

ANS. The pressure will be equal to the weight of a vertical column of water 34 feet high, as $62.5 \times 34 = 2125$ pounds per square foot of section.

QUES. 3. If 62.5 pounds were lifted 34 feet high, how many foot pounds of work would be done, and if 62.5 pounds were to fall 34 feet, how many foot pounds of energy would be stored in the mass, and what would be its acquired velocity?

ANS. The foot pounds of work done in raising 62.5 pounds to an elevation of 34 feet would be, $62.5 \times 34 = 2125$ foot pounds. The energy stored in a mass of 62.5 pounds, after falling 34 feet, would be 2125 foot pounds and the final velocity of the mass would be $\sqrt{34 \times 2g} = v$, or $\sqrt{34 \times 64.32} = 46.76$, the velocity required in feet per second.

QUES. 4. What is the meaning of the expression $\frac{(H-h)}{H} 2125 = p$?

ANS. The letters represent the following values: $H = 34$, the length of the vertical column that balances the pressure of the atmosphere; h equals the height of the pump piston above the level of the water that is pumped, and therefore it reduces the effective pressure urging the upflow of the water, hence h is negative to H; p is the effective pressure, and 2125 is the pressure of the atmosphere in pounds per square foot, and therefore $\frac{(H-h)}{H} 2125 = p$ means that p is the effective portion of the 2125 pounds pressure that remains after h has been allowed for.

QUES. 5. What is the meaning of the expression $\frac{(H-h)}{(H+h)} 2125 = p$?

ANS. As the letters have already been explained, we need not again refer to their meaning and their use. The expression $\frac{(H-h)}{H} 2125 = p$ is purely theoretical, and makes no deduction from the calculated pressure for the resistances common to all pumps, put as the sum of the resistances in a well-constructed pump is correctly allowed for by the equation $(H-h)\ 2125 = (H+h)\ p$, it is used where the working efficiency of a pump is required, as $\frac{(H-h)\ 2125}{H+h} = p$.

QUES. 6. Why are small water-ways through the suction valves of pumps objectionable?

ANS. A small water-way through a valve reduces the velocity of inflow into the pump cylinder, and, therefore, when p is small the pump has to be run at a low velocity, and therefore does a reduced quantity of work per minute. A small water-way also sets up an increased resistance, and wastes a high percentage of the motive power.

QUES. 7. What is the best object lesson we can have in the right dimensions we should give to the water-ways of valves, and the suction or tail-pipes of pumps?

ANS. The best object lesson to learn how to determine the right dimensions of suction valves, and the areas of tail-pipes for pumps, is found in the case of a "grossly magnified error," such as making the area of the suction valve excessively small, or the diameter of the tail-pipe excessively small, and noting the results. Again, the correct sizes can be found by correcting one excess, by its opposite in excess, that is, by making the water-way of a valve too large, and the diameter of the tail-pipe too large, and then finding where the best results are found between the extremes of the grossly magnified errors.

(To be Continued.)

MINING METHODS.

What is Coal Dust?

93. **What Is Coal Dust?**—We mean by the word dust, a crowd of minute particles of solid matter that are easily suspended in air in motion; and as this definition applies to all solid matter in a state of very fine division, we have clay dust, road dust, stone dust, brick dust, mill dust, grain dust, cotton dust, woollen dust, powder dust, coke dust, coal dust, and many other varieties.

The definition just given, however, is only that of the popular conception, and it is quite sufficient to enable one man to understand another when its presence is announced, or a cause is indicated that will produce it, but as its presence in the air of mines is a cause of danger, we require to know a great deal more about it.

We ought, for instance, to know the sizes, weights and relative surface areas of the particles, and the laws that regulate their suspension and velocities of descent; and unless we know these particulars we are incompetent to discover the right means of keeping under proper control the dangers that arise in the presence of dust. The only classification at present recognized is "The dusts of different coal mines," "Heavy dust and flocculent dust," and unless we can assign the reason why the dust of one mine differentiates from that of another the classification is worthless; and as the terms heavy dust and flocculent dust are only relative ones, they have no applicate value, and therefore we are compelled to originate a classification that will enable us to determine when dust is and when it is not dangerous, and also how to treat it to keep it within the bounds of safety.

However minute the particles in a dust cloud may be, we ought to know their sizes, weights and velocities of suspension, and as the means are at hand that will enable us to find these values, it is our intention to begin in this lesson to explain the standards of measure and their unit values and the scales for weighing, and the unit values of the weights to be used in dust-gauging. The measures and weights of the particles can be deduced, and also the velocities required for suspension, by the application of the laws of the velocities of falling bodies, and the relationship of the areas of the surfaces to the weights of the particles.

When a body falls in a vacuum it accelerates or quickens its speed at the rate of 32.16 feet every second, but this law is very much modified when a body falls in air, indeed the increase per second *decreases* every second, until the acceleration vanishes altogether, and if the body falls from a great elevation, the positive acceleration actually becomes negative, or the body begins at

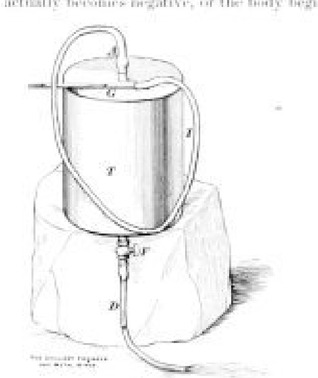


FIG. 133.

last to have an increasing retardation per second, as the result of the density of the air increasing. The velocity at which a body falling in air will cease to accelerate is of easy determination when the weight of the body and the area of its end surface is known.

We are all familiar with the fact that a spherical shot thrown by a smooth bore gun meets with a greater resistance from the air, on account of the large area of its "end," than a cylindrical shot from a rifle cannon with a small "end" area. If a cube or sphere of iron and an iron bolt are let to fall down a deep shaft at the same moment of time, the bolt will reach the bottom before the sphere, and if the shaft is *very* deep, the differences in the times will be considerable, and to make the matter clearly understandable, let us calculate a case. Suppose then we let fall a cube of coal equal to a cubic foot in contents, and let us find at what velocity it will cease to accelerate while falling. Then, let the specific gravity of the coal be 1.3 and the weight of a cubic foot will be $62.5 \times 1.3 = 81.25$ pounds. The resistance due to the air in which this cube is falling can be found as follows: 1,800,000 = the square of the velocity of air rushing into a vacuum from atmospheric pressure, 2,120 = the pounds pressure per square foot of the atmosphere, 81.25 = the weight in pounds of the cube of coal that falls.

The law of the resistances of air produced by bodies falling in it is: A body ceases to accelerate when falling in air, when the resistance per square foot of end area, is equal to the weight of the body; and as the resistances vary as the squares of the velocity it follows that $\sqrt{\frac{1{,}800{,}000 \times 81.25}{2{,}120}} = \sqrt{68{,}986} = 262.66$.

That is to say the resistances vary as the squares; or if 2,120 pounds require a square of velocity of 1,800,000, 81.25 pounds will only require 68,986; or in other words, when our falling cube of coal reaches a velocity of 262.66 feet per second, it cannot further accelerate, and if the density of the air did not increase, the body would continue to fall at that uniform velocity forever. In our next lesson we will proceed to show how the weights and sizes and suspension velocities of the particles in a dust cloud can be found, and to aid the description, suitable figures will be introduced, but in the meantime, the reader is advised to give special attention to this lesson, as all future ones will be based upon it. Let us then clearly understand that the velocity at which a falling body ceases to accelerate, is what we have noticed as "the velocity of suspension." Having, however, found the velocity of suspension for a cube of one cubic foot of coal, we can now dispense with the number 1,800,000 and adopt that of 69,000 for our unit, because the squares of the velocities of suspension vary as the weights per square foot of end surface; for example, suppose we split our cube into two slices, each one square foot in plan, and 6 inches thick, and let one of these slices fall flat, it is clear that the square of the velocity of suspension would be $\frac{69{,}000}{2} = 34{,}500$, because, we now have halved the weight per square foot of each end surface. It would be impossible, however, for the slab of coal to keep horizontal, and if it fell endwise it would actually have the same velocity of suspension as the entire cube, because for half the weight, it now has only half the end area; but if we split the slice into four parts, each one of them would be a cube one-eighth of a cubic foot in its contents, and yet it would have an end area equal to one-fourth of a square foot; if, therefore, we multiply $\frac{1}{8}$ and $\frac{1}{4}$ each of them by 4, we have $\frac{\frac{1}{8} \times 4}{\frac{1}{4} \times 4} = \frac{\frac{1}{2}}{1} = \frac{1}{2}$, then, $\frac{69{,}000 \times 1}{2} = 34{,}500$ the square of the velocity of suspension as before. We have indicated at any rate, the route along which we are going to travel, and to allow breathing time for study, we will illustrate the construction and use of an instrument of importance in the dust investigation. This apparatus is capable of considerable modification, but the one before us is the best we could select for simple explanation, and it is illustrated by Fig. 133. The use of this instrument is to measure the weight of the dust in a cubic foot of the air of a mine by passing it through a cotton wool filter. The filter consists of a glass tube G, which is filled loosely with fine fibrous cotton wool, to which the very small particles of dust adhere when they are carried into the tube with the stream of air. The air is set in motion and measured by a water displacement which proceeds as follows: At the beginning of the measurement the tank T is full of water, and this can be run off through the faucet F and out through the hose pipe D. Now let us suppose it is required that the weight of coal dust in a cubic foot of air should be known, and let us suppose that the tank T is full, and that its capacity is three cubic feet. If now the faucet F is opened, the water will flow out through the hose D and make a depression, and now the air will press through the filter G, and then after being clarified will flow through the pipe I and enter the top of the tank at A and so on until the tank is empty of water. Now the dust that has been filtered out of the air will be safely lodged among the fibres of the cotton wool, and, therefore, the tube is now disconnected from the pipe I, and carefully weighed, and if it is found to be fifteen grains heavier than it was before the filtration began, we know that every cubic foot of air contained 5 grains of fine coal dust in suspension before it was tested.

(To be Continued.)

Mine Harness.

One of the very necessary supplies at mines is mine harness, and as the various parts of a set are constantly wearing out or breaking, owing to the very severe service, the necessity of durable portions subject to strain is urgent. Hames, in particular must be made of such materials and in such shape as to meet hard strains and rough usage. The hame illustrated herewith, shows a

PITTSBURG HARNESS SUPPLY CO. HAME.

well shaped, properly protected and reinforced article fitted with strong and well arranged fittings.

Another specialty manufactured by the Pittsburg Harness Supply Co. is a double throat hair faced mine collar which has met with much favor among such large consumers as the Monongah Mining Co., W. J. Rainey, Cumberland Coal Co., and many others. This collar is shown in the annexed cut.

PITTSBURG HARNESS SUPPLY CO. COLLAR.

The Pittsburg Harness Supply Co. is the largest harness house in Western Pennsylvania, and, while having an important part of its business devoted to mine work as a specialty, also manufactures and carries a complete stock of buggy, coach and coupe harness, as well as a full line of harness supplies of all descriptions. Such harness supplies as are necessary for repairs at mines are shipped to purchasers on shortest notice. The facilities of this company are such that orders for supplies are filled in the shortest possible time, the large domestic and export trade done by the company making it necessary for them to carry the largest stock in the city of Pittsburg. In fact, few houses in the country carry larger stocks. Their illustrated catalogue will be cheerfully mailed to any mine manager requesting it. Their place of business is No. 50 Seventh street, Pittsburg, Pa.

MISCELLANEOUS.

THE SOURCE OF MALARIA.

The investigation on the source of malaria has had the writer's attention for over two years, and in that time a large amount of clinical testimony has been collected from all known malarial districts in North America; the final report, however, will hardly be ready for publication for some months, but from the work already completed certain facts have been obtained which will be embodied in this short notice.

The introduction of artesian wells, first by the railroad companies who desired a larger supply of water than had hitherto been available, and the accidental use of that water by the people in the immediate vicinity, soon produced a marked diminution of malarial trouble in those localities. The artesian supplies were, on the whole, so satisfactory to the railroads that their introduction became very rapid, and in a few years most of the South Atlantic lines depended upon this source of water supply. The evidence that in the exclusive use of the deep-seated waters there was entire immunity from malarial trouble was apparently so incontestable that I determined upon a critical examination of all waters known to produce malaria and those that in malarial districts were proof against it; this examination is not only chemical, but biological and pathological.

In the present state of our knowledge we do not expect to be able to draw a sharp line between waters that produce malaria and those proof against it by purely chemical analysis; nor, on the other hand, can we hope to identify by biological examination the protozoa producing that trouble; but we may by the former succeed in isolating certain toxic products peculiar to those waters only, and by the latter a certain line of testimony that, in conjunction with the chemical investigation, will yield very valuable results. The work thus far has proved satisfactory beyond expectation, and, from the work already done, and the character and amount of evidence before me, I am justified in stating that the long-current belief that the source of malaria is in the air is in error.

The germ, which is of soil origin, is strictly a protozoa, and reaches its highest development in low, moist ground, with a favorable temperature. Surrounded by the proper soil conditions, this protozoa passes from one stage of life into another with considerable rapidity; so that in the present state of our experimental knowledge it is impossible to identify it, nor is it probable that by culture we shall be able to produce the accepted Laveran germ outside of the human system.

As a rule, the potable water from the malarial districts is derived from driven wells not over twenty-two feet deep, in soil with clay or some other impervious substrata, which water is generally cool and palatable, often sparkling clear, but more frequently a little turbid. This water is filled with an incalculable number of these germs in all stages of development, and if used as a potable water they naturally find their way into the system through the alimentary channels. This protozoa passes through so many forms or stages of life that in some stages it is light enough to float and be transported by the moist air of low grounds, but in this state it is comparatively harmless except under most extraordinary conditions; it is not until the surface water is used that the mischief begins, when, by reason of higher development, it has become much more virulent than that floating in the air. A very short period of incubation is sufficient to develop a severe case of malarial fever in the newcomer who uses the surface water.

From personal observation I know that the exclusive use of pure, deep-seated water affords entire immunity against malaria in sections of country where no man dared live using the surface water. Nor must it be understood that the exclusive use of pure water simply fortifies and strengthens the system against the attack of the germ. The water is the primary cause of infection, which acts as the direct carrier of the germ into the system through the intestinal tract.

The impression that malaria is caused by purely atmospheric influences has become so fixed in our minds that, unless we come in actual contact with the evidence produced in the use of pure water as against that heretofore used, the physician will, in all probability, be very slow to allow himself to be convinced that the word malarial (*mal*, bad; *aria*, air) is a misnomer, and that malaqua (*mal*, bad; *aqua*, water) is the word that should be used to convey the pernicious effects known under the name of malarial fever.—*From The Medical Journal.*

A NATURAL BEAR TRAP.

In the Yellowstone National Park there is a locality to which was given the appropriate name of Death Gulch. It was discovered in July, 1888, by W. H. Weed, of the geological survey, and the writer. It is situated in the extreme northeastern portion of the park, on Cache creek, several miles above its confluence with Lamar river, or the east fork of the Yellowstone, as it is often called. It is easily reached by a horseback ride of about five miles from Soda Butte, the mail station on the route between the Mammoth Hot Springs and the little mining town of Cooke City, Mon.

In the center of the former hot spring area of Cache creek the creek makes a broad pool which "boils" furiously from the action of escaping gas, and is, in fact, a natural soda water fountain. Small particles of sulphur are also floating in the water, and are being deposited about the edge of the pool. Just above the pool the creek has cut through a bank of sulphur and gravel, and a few yards beyond is the debouchure of a small lateral gully or gulch coming down from the mountain side. Following this gulch we come within a quarter of a mile to the end, or, rather, beginning, which is a "scoop" or basin about 200 feet above the creek. The sides of the gulch, except at the head, are very steep, and in the bottom flows a tiny stream of cold, clear water, sour with sulphuric acid.

We were making our way up this gulch and had just entered the terminal portion when our attention was directed to a huge silver-tip grizzly bear within twenty feet of us. He was in such a natural position that we supposed him to be asleep, but a closer inspection showed him to be dead. The body was perfectly fresh, and could hardly have been dead two hours. We examined the body very carefully for bullet holes or other marks of injury, but beyond a few drops of blood under the nose there was not the slightest trace of violence. But during this examination we were conscious of the near presence of other decomposing matter, and a short examination revealed the presence of the more or less decomposed bodies of four more bears, an elk, several squirrels, rock hares, besides numerous dead butterflies and other insects. One of the bears was a good-sized cinnamon bear, and was in an advanced stage of decomposition. The other skeletons were almost denuded of flesh, although the claws and much of the hair remained.

At first we were unable to account for this strange accumulation of dead bodies of animals until a choking sensation of the lungs suggested the presence of noxious gases, and the death of the animals by asphyxiation. The hollows were tested with lighted tapers for the presence of carbonic acid gas, with only slight results, but as a strong wind was blowing down the gulch at the time, the gases would have been rapidly diffused. A strong sulphurous odor was present. On a subsequent visit, however, there was no wind, and the presence of carbonic acid gas was more manifest.

It is likely from the nature of the surroundings that there is never a very great accumulation of this deadly gas, for it would naturally tend to flow down the ravine, and be rapidly dissipated. If the head of the gulch was a more marked basin the accumulation of gas would undoubtedly have been very marked, and the consequent fatalities more numerous. The first animal doubtless wandered in and was overcome, and thus served as a bait to lure the others in turn to their destruction. Certain it was, the body of the bear that was fresh on our first visit was a widely advertised bait on a second visit some weeks later.

As Mr. Weed has suggested, this gulch has doubtless served as a death-trap for a very long period of time, but these bodies and skeletons must be the remains only of the most recent victims, for the ravine is so narrow, and the fall so great, that the channel must be cleared out every few years, if not annually.

Since the discovery in 1888, Death Gulch has been visited by people in this vicinity, and it stands without a peer as a natural bear trap.—*From the St. Louis Republic.*

UNIQUE MAIL ROUTES.

Probably the most unique method of transporting mails known to the United States Post Office Department is that in daily use between Telluride and Smuggler. The mining town of Telluride is located at the head of a picturesque gulch. The mountains rise in majesty to cloud-piercing heights about the town, and from every precipitous draw between the giant peaks foaming cascades, waterfalls and roaring streams come down from the snow-laden summits to swell the torrent of the San Miguel, which rushes through the town. Four miles above Telluride is Marshall Basin, situated among the snowy peaks and far above timber line, and in this basin is the little mining settlement of Smuggler, where the employes of the great Smuggler-Union and Tom Boy mines make their homes. Although the inhabitants have a post office of their own the postal authorities do not guarantee a regular service because of the difficulty of keeping a trail open in the winter time. The dangerous snowslides constantly threaten destruction to the hardy miners who scramble through the snow up the steep trails to the settlement in Marshall Basin. Until in recent years all supplies for the camp in Marshall Basin were transported thither by pack animals. Timber for the mines, coal for the boilers, and iron rails were dragged over the trails or packed securely about swaying pack saddles and carried to an elevation of 12,000 feet by the burro. When winter closed down and the burro trains could no longer be driven on schedule time the miners would take turns in going down on snowshoes to get the mails and a few necessary supplies that could be carried upon their backs.

But the practical application of the endless chain by the inventor of the Hudson tram has greatly facilitated the transportation of supplies from Telluride up to Marshall Basin. Great iron buckets, each carrying down the mountain a half ton of ore, furnish by their weight the active power which drives the endless chain from which they are suspended. In these buckets, upon their return, the necessary supplies for the camp are placed. One of the buckets is painted a bright red color and the letters "U. S. Mail" in black designate the use to which it is put. The daily mail for Smuggler post office is now delivered as regularly across the four miles of precipice, snow-buried gulches, and giant mountain ruggedness and with as much safety as between two settlements in the prairies of western Kansas or Nebraska.

Just over the range of peaks from Marshall Basin is the post office of Mt. Sneffels, near the famous Virginius mines, seven miles above Ouray, a mining town which is as picturesquely located as Telluride. A good wagon trail leads from Ouray up the mountain side to Virginius mine, but in the winter time the trail fills with snow, an occasional slide destroys the continuity of the route so that sledding cannot be done, and the mails are carried by men with snowshoes. There are a number of snowshoe routes in the mountains of Colorado, but none more hazardous than this one. The men who carry the mails over snowshoe routes seldom meet with accident. They have learned to understand the peculiarity of snowslides, and when a high wind is blowing or other meteorological conditions make traveling along the trails dangerous, they postpone their trips until settled weather returns. Sometimes the mails are two weeks in arrears when the mail carriers dare to venture forth.

A free delivery system is in vogue in the mining districts, though the postal authorities have nothing to do with it. From every mountain post office trails diverge up every draw and gulch. A miner setting out for his cabin, perched somewhere far up on a mountain, will take with him all the mail belonging to his neighbors, though they may live miles from his place. At each turning-off point, a small box will be found nailed securely to the trunk of a stout old pine tree, and upon this box is scrawled the names of all the miners who must pass that tree in going to their respective cabins. Into this box the last man from town deposits all the mail belonging to miners living up that particular gulch. From that gulch a miner will occasionally descend for the mail, and as he returns up his trail, he deposits in turn the several pieces of mail in other boxes placed at convenient points. In this manner one man can save many a weary step to other miners who live out the long winters in the very heart of the Rocky Mountains. Mails are collected in a similar manner, and often small errands are likewise done. Money deposited in mail boxes for the purchase of stamps, tobacco, and other notions light in weight, is always properly respected and the mission fulfilled, no matter how much the snow-shoe pedestrian may be under the influence of good fellowship as he returns from town.—*From New York Sun.*

CHINESE TELEGRAPHY.

All the principal cities of China are now connected with one another and with Pekin, the capital, by telegraph. Recent visitors to China say, however, that telegraphing there is a laborious and an expensive process, and that the lines are a charge upon the State treasury instead of a source of revenue.

The despatches are, of course, sent in Chinese, for not one in many thousands of the natives knows any language except his own. But the Chinese have no alphabet. Their literary characters, partly ideographic, partly phonetic, number many thousands. It is simply impossible to invent telegraphic signals that would cover the written language. Here was an obstacle in the way of using the telegraph at all.

The difficulty was obviated by inventing a telegraphic signal for each of the cardinal numbers, and so numbers or figures might be telegraphed to any extent. Then a code dictionary was prepared, in which each number from 1 up to several thousands stood for a particular Chinese letter or ideograph. It is, in fact, a cipher system. The sender of the message need not bother himself about its meaning. He may telegraph all day without the slightest idea of the information he is sending, for he transmits only numerals.

It is very different with his friend, the receiver. He has the code dictionary at his elbow, and after each message is received he must translate it, writing each literary character in place of the numeral that stands for it. Only about an eighth of the words in the written language appear in the code, but there are enough of them for all practical purposes.

But the Chinese system has its great disadvantages. Men of ordinary education have not sufficient acquaintance with the written language to be competent telegraph receivers, and the literati are not seeking employment in telegraph offices any more than our college professors are. So the Government recruits its employes with much difficulty. Besides, the patrons of the telegraph are comparatively few in number. There are almost no Chinese who have business relations all over the country, as is the case with many thousands of our business men. The public is not invited to buy stock in the Chinese telegraph lines, and if it was, nobody at present would buy with a view to dividends. The receipts do not equal the expenses, and the Government makes up the deficit.

There is another great disadvantage of the Chinese telegraph system. All over the world the movements of railroad trains are regulated by telegraph. The orders received by the station agent are filed in plain view of the employees, and if need be the switchman may take temporary charge and carry out the instructions from the central office. Railroads have been introduced into China to a very small extent, and there is talk of greatly extending the service. But how about running the trains?

A writer in *Le Mouvement Colonial* of Paris says that if railroads are introduced to any extent in China the personnel must be exclusively European and American, or recruited from the literary class. He says the Chinese Government will not take foreigners into its service, and that the educated men of China, who alone among the people have sufficient knowledge of the written language to be intrusted with the actual running of trains, would refuse most emphatically to be either train hands or station agents.

This is one of the many small stumbling blocks in the way of China's progress, but it is quite effective in its way.—*From the "Statesman's Year Book."*

HAWAII'S BURNING MOUNT.

After an interval of thirteen months of quiescence the volcano Kilauea is again in action. On the evening of Jan. 3, at about 11 o'clock, the inhabitants of Hilo, the largest town on the great island of Hawaii, noticed a peculiar rosy glow in the sky toward the southward. The tidings flew rapidly and all the population of the lovely village was aroused and thronged the streets to gaze upon the beautiful sight. It was known at once that Kilauea had once more broken forth in eruption and the news was hailed with joy. This statement seems a trifle startling when one considers the havoc which volcanoes in general are apt to play with the outward world; but it must be remembered that Kilauea is unique among volcanoes, and that, lively as may be its eruptions, its great sea of molten lava has never been known to overflow its mighty banks. The volcano is, in fact, the great show which the Hawaiian people have for their continental visitors.

Although it is a journey of a day and a half from Hilo to Honolulu the news soon reached there, and a party was at once made up to visit the volcano, and when the Kinau, the regular Hilo boat, finally drew away from her moorings and steamed out of the harbor, she took with her one of the merriest parties which has sailed out of Honolulu for many a long day. The day was glorious; the sea and sky, as always, deeply, beautifully blue. The southward course was taken, the tourists passing upon their trip the extreme southwestern point of Molokai, the green shores of Lanai, and the rock coast of Kahoolawe. Here the prow of the Kinau was turned northeastward, into the channel which separates the islands of Maui and Hawaii. Passing Upolu Point, she swung about until her prow pointed to the southeast and skirted the great island of Hawaii, until the lovely Hilo Bay opened before us.

As night fell the rosy glow of the sky, far away above Kilauea, became intensely vivid, and the tourists, charming as was the voyage, were all impatience to reach the scene of nature's great display.

It was but a short time after the arrival of the boat before the entire party was in motion, the majority in carriages, but some on horseback. Quite a number of these last were ladies, who, anticipating this feature of the trip, had brought their riding habits with them. A few of these were native Hawaiian women, whose custom it is to ride astride, and their flowing habits, reaching nearly to the ground upon each side of the horse, and streaming out in the rear when they rode swiftly, were a picturesque feature of the cavalcade. The road is bordered upon both sides with luxurious plant growth—palms, great tree ferns, and other tropical foliage; but beyond this and partially hidden from the road are the coffee plantations; for this is the region where the coffee plant grows, and now that the crown lands are open for settlement, this region is soon expected to rival in importance the great sugar-producing areas in other portions of the islands.

The journey to Kilauea from Hilo is not far from forty miles, and although the road is excellent, it was nearly sundown when we reached the Volcano House, where we found ample accommodations. The sensation of sitting down to a comfortable meal, and, above all, of going to bed in a house situated close to the crater of a volcano, is decidedly curious, and one which can be realized nowhere in the world but here. We did not, however, retire at once to bed, weary as we were from our journey, for it is after nightfall that the fearful sublimity of Kilauea is seen at its best. It is not safe, however, to venture far away from the Volcano House, even in the daytime, without a guide, for what may seem, perhaps, as solid ground, covered with a tangle of flowering vines, may be a pitfall, where the indiscreet wanderer may receive an unlucky tumble.

The volcano, as has been said, never overflows the upper rim of the immense crater upon the floor of the tremendous depression upon the summit of the mountain, which scientists have called the caldera. The outer rim of the caldera is several hundred feet above its floor, and it is a hard but not dangerous scramble down the declivity. The floor is composed of cooled lava, and is evidently only a crust covering the immense lake of molten fire which boils and seethes beneath. Here and there, as the traveller crosses this floor, are fissures through which are visible the fires below, and a stick thrust into one is quickly charred.

It is a walk of a mile or two over this lava floor before one reaches the great lava lake, Halemaumau, or the House of Everlasting Burning. Great cliffs surround the pit, up which one must scramble. Once at the summit, he gazes down into the awful chasm, for hundreds of feet, into the seething mass of boiling lava below. For more than a year prior to the 3rd of January the great lake had been quiescent. The great mass of lava had sunk away, down the vast shaft, until scarcely a vestige of it was to be seen. But upon that date it began to rise in the shaft, boiling and tumbling as it came. Within twenty-four hours it had risen to the top of the shaft and had begun to overflow upon the floor of Halemaumau. In a few hours a lake, 250 feet in length by 200 in width, had formed within the pit, and this hourly increases its area until it reaches its normal size, when the volcano is in full action, which is about 1,500 by 1,000 feet.

It is impossible to describe, adequately, the tremendous sight. Standing upon the crest of the cooled lava which surrounds the pit, we gazed down 400 feet into the cavernous depths, upon this enormous lake of fire, its surface covered with boiling fountains of lava. In places the lake is covered with a thick, black crust, through which the fires glow with an unearthly gleam. Now and then, from the centre of one of the fountains, a jet of molten lava, mingled with steam, is thrown up, but not with tremendous violence. Its force spent, it falls back upon the crust, where the glowing mass remains for a time until it gradually fades from a brilliant red to a rosy glow, and at last to the dull black of the crust. This crust is not continuous, but is formed in detached sheets, which, from time to time, are upheaved by some great commotion below and, turning, pitch downward and disappear below the glowing red surface of the lake. A period of great activity then ensues, the floating cakes of encrusted lava being tossed violently about, like cakes of ice upon a stormy sea, pitching and plunging until the whole surface of the lake is a glowing mass of fire, from which the onlooker draws back and shelters his face from the intense heat. By and by the lake, little by little, becomes more quiet, the intense agitation ceases, and again the sheets of black crust appear upon the surface.

When these ebullitions occur the air is filled with a curious substance, to which is given the name of "Pele's Hair." In the mythology of the ancient Hawaiians, the goddess Pele made her home in the House of Everlasting Burning, and to her the priests were wont to offer incantations and sacrifices to appease her wrath. Pele's hair comprises masses of minute threads of lava, drawn out, it is popularly believed, by the action of the wind upon the sprays of boiling lava. Scientists, however, find another explanation of the phenomenon in the sudden liberation of the watery vapors which are mingled with the molten lava, beneath the surface of the lake. Whatever may be the scientific cause of this curious formation, it remains that great bunches of Pele's hair, resembling finely shredded asbestos, are always found clinging to the rough lava rocks to the leeward of Kilauea, and it is gathered in large quantities by tourists as a souvenir of the visit to the volcano.

It is impossible to adequately describe the gorgeous terrors of Halemaumau; to picture the tremendous intensity of color upon the surface of the lake; to describe the varying forms of the rugged lava wall, which rises for hundreds of feet above its surface, and forms the enormous pit in which it seethes and boils, to the interest and terror of the beholder; to picture the varying shades of brilliant red, yellow, orange, and saffron with which the rugged walls are here and there be-pattered, and by which the dense blackness of the surface is intensified; and, above all, to be able to show that pall of translucent vapor which forever hangs over the surface and through which the remoter wall of the crater is indistinctly visible; and, too, that light, billowy cloud which ever hovers high in the air above Kilauea, and which is tinged with a rosy red, for a beacon light to seamen miles distant upon the ocean.

Kilauea is fascinating, yet terrifying, to him who gazes into its depths; but the longer one gazes, the more does the sentiment of awe and of wonder overcome that of fear. All are loath to leave it, and linger long upon the brink of Halemaumau, returning again and again to gaze into its awful depths.—*From the Boston Evening Transcript.*

COLORS ACCORDING TO LATITUDES.

An endeavor to find a cause for the predilection of certain peoples for a certain color, while such color is put under the ban in another latitude, must, we think, prove futile. Why is yellow, as a general thing, displeasing to us, while in Guiana and the Antilles it is the color preferred par excellence? Why do we like blue, and why do the Japanese detest red? This is a matter of surroundings and habits and also of fashion for certain countries.

But if the cause is of slight consequence, the fact is, nevertheless, of interest to note, and we have evidently here ideas of extreme importance to the exporting manufacturer whose products are designed for remote peoples having customs different from ours. At the epoch at which Japan opened its ports to European commerce, a certain manufacturer of Havre hastened to ship thither fabrics of the most beautiful red. This detail, of trifling appearance, had escaped him. It proved a disaster and the goods remained on his hands.

Dr. Felix Regnault has endeavored to put a little order into the nomenclature of such preferences, and finds, along with all anthropologists who have studied the question, that savages are especially fond of luminous and dazzling colors. If we turn to the negro, the North American Indian, or the Polynesian, we find that he always has a predilection for red.

According to Cook, the New Caledonian admires everything that is red and is prodigal of this color for the embellishing of the poles of his huts, his carvings, and his images.

In New Zealand it would only be necessary to paint an object red in color to have it become a taboo.

The only colors known to the natives of Gaboon, before the arrival of the whites, were, according to Dybbac, red, white and black. To-day they use blue as a color of mourning.

Capus remarks that the color preferred by the Siapoch Kafirs, a people of Afghanistan, is red, which is especially the color of certain ornaments of the chiefs.

Among the ancients the chosen color was purple.

On the contrary, the peoples of the north have a particular liking for somber colors.

We are especially partial to blue, and regard yellow as ridiculous.

In Japan, light Prussian blue and greenish blues prevail in clothing.

The savage Ainos of the island of Jesso, according to Dybowski, prefer blue and tattoo themselves with this color alone.

Let us now pass to the French colonies. In Congo, De Brazza always carried bright red cotton cloth for his exchanges. On the contrary, in the Soudan, we have to do with the Mussulmans, who are more civilized. The medium of exchange is here blue or long cotton cloth. The latter is dyed indigo blue in the Indies, and any other shade of blue would be rejected.

The Mussulman negro is distinguished from the fetichist negro by his love for blue, while the fetichist prefers red. The former tattoos himself with blue, while the latter smears his body with ocher.

In the French Indies, the clothing worn is especially red and yellow, while the blue finds little favor. One of the main affectations of the women is to color their skin with saffron.

In Cochin-China the colors most used are yellow and red, and then comes green. The gods are gilded.

The negroes and the natives of Guiana and the Antilles have an especial fondness for fabrics of a yellow ground. Fashion does not lose its rights and the ground always persists, but the designs upon it may be modified.

In Tahiti the aborigines adopt a pale rose color for their clothing.

The Germans make a singular deduction from the passion of savages for gaudy colors, and have concluded therefrom that they do not perceive violet, blue, or green. These colors, in fact, have no name in the language of some of these peoples. Without going farther, moreover, the ancients had no special names to designate all colors. The Israelites knew only white, black, green and red, and in Homer, according to Gladstone, we find special names only for green, blue, and violet. But why not simply admit that savages, having a language poor in precise terms, denominate only that which strikes them, and that somber colors being indifferent to them, they do not think to mention them by a specific name.

Thus, the Battas of Sumatra, in contact with the Dutch, have taken the term blue from the language of the latter to designate that color, which they distinguish perfectly. So, too, certain African peoples have borrowed the word blue from the English. They, therefore, distinguished the color previously, but did not concern themselves about giving it a name. The Cree Indians of British America call blue by a name signifying "dead man's country color," i. e., "sky color," the spirits of the dead being supposed to ascend to the sky.

The ancients had no special terms to designate certain colors, and yet they used them in profusion upon their monuments.

The Egyptians used yellow, red, blue, green, brown, white, and black, and had a correct perception of the harmony of colors.

The two colors that occupy most space in the decorations of the enameled bricks of the Assyrians are blue and yellow. Blue almost always furnishes the ground, while the majority of the figures thereupon are yellow.

The Persians made much use of these two colors, but they likewise employed green and red. Moreover, they set off their palaces with plates of gold, silver, bronze, ivory and choice woods.

Finally, the Greeks were fond of color. We know that they had the habit of painting the frieze of their structures blue. In the Parthenon, the front of the metopes was red, and blue and yellow were distributed throughout the rest of the edifice.

In our epoch, it seems that we are timidly returning to ancient practices. At the Universal Exposition of 1889, polychromy was tried, but blue always predominated.—*From "La Science en Famille."*

DISCIPLINE AND ORGANIZATION ON AN OCEAN STEAMER.

Just as the government of cities is divided among the Mayor, Aldermen, Boards of Commissioners, etc., of various departments, so the administration of a giant steamship is divided into specialties. The mayor is the chief officer of the city. The captain is the chief officer of the ship. He is more than that. From the time she leaves port until she enters port he is master of the life and liberty of every person aboard the ship, as well as of all the property in it. He is an autocrat. Of course, he must administer his authority wisely. Unwise autocrats don't last long, whether afloat or ashore.

The head of each department is responsible for all that goes on in it. The first officer is at the head of the crew, or navigating department. The chief engineer directs everything connected with the engines. The chief steward has full control of all that has to do with the comfort of the passengers and crew. Each of these chiefs makes a written report at noon every day. Thus the captain is kept informed of everything pertaining to the ship's welfare.

Every one of the senior officers of the ship is a duly qualified master, capable of taking her around the world if need be. The day is divided into "watches," or tours of duty, of four hours each. One junior officer is on the bridge with each senior officer on duty. The senior officer directs the ship's course. He never leaves the bridge while he is on watch. Should he do so he would be dismissed at once. There is no excuse possible. It would be just as if he had died suddenly. His friends would all feel sorry, but nothing could be done to help him. Two seamen are always on watch in the bow of the ship and two more in the foretop. Twice as many are on the lookout in thick weather.

Observations are taken every two hours. In the good old sailing ship days the captain was content to "take the sun" at noon every day. If the sky was cloudy for a day or two it really didn't matter much, for he could jog along on dead reckoning. But on an ocean greyhound, rushing over the course between New York and Europe at the rate of more than twenty miles an hour, it is highly important that the ship's position be known all the time. Fog may come down at any moment, observations may not be obtainable for ten or twelve hours. The positions of more than 100 stars are known. By observing any one of these the ship's whereabouts can be ascertained in a few minutes. Of course, the "road" becomes more or less familiar to a man who crosses the ocean along the same route year after year. Yet this familiarity never breeds contempt or any carelessness. No man knows all the influences that affect the currents of the ocean. You may find the current in one place the same forty times in succession; on the forty-first trip it may be entirely changed. Some times a big storm that has ended four or five hours before the steamship passes a certain place may have given the surface current a strong set in one direction. There is no means of telling when these influences may have been at work, save by taking the ship's position frequently.—*From Harper's Round Table.*

THE SHRIMP.

The shrimp is a scavenger; it will eat almost anything. It is a greedy creature; it may often be seen in aquarium tanks to seize a piece of food weighing more than itself. If this scrap should be lying on the bottom, the shrimp with its first effort upon swooping down upon it might raise it clear and then be compelled to drop it, or to sink with it again to the bottom, there to attack it piecemeal. The shrimp is often put in aquarium tanks to help keep them clean; it seeks out and eats neglected scraps and little bits of food put in for other marine animals, but which the others may have missed and which may have settled down in crevices or other by places. But while the shrimp is thus useful as a scavenger, it is necessary at feeding time to see that it does not get also the food intended for the other animals; the shrimp is exceedingly quick in movement and it may dart down and seize the food out of the grip of an animal much larger than itself, and it would be equally ready to take food from the helpless sea anemone or the fighting crab. A tiny shrimp would not for a moment hesitate to feed upon a dead fish held in the grasp of a lobster, trusting to its agility to escape if the lobster should resent the intrusion.

But while the shrimp is able to and does hold its own remarkably well for one of its size, life is by no means all plain sailing for it; there are other creatures of the sea that are quite as quick and quite as merciless, and that snap up the shrimp whenever they get a chance. Here may be a dead menhaden lying on the bottom with five hundred shrimps at work upon it pulling and hauling. One shrimp may get an extra big piece, only to be attacked by three or four other shrimps that leave the menhaden and fight with the shrimp that has the fragment for the possession of that. The water is alive with shrimps about the dead fish.

Along comes a big weakfish or a striped bass. The weakfish may see the shrimps feeding from a distance of ten or twelve feet away. If the weakfish ever laughs, it probably laughs on an occasion like this. It may approach along the bottom or it may dart down obliquely, and dash through the mass of shrimps with open mouth, sweeping away a dozen of them and dispersing the rest. The dispersal, however, is likely to be but temporary; the weakfish is not apt to return to this particular quarry; it seems to regard the meeting with the shrimps around the menhaden as only an incident of its day's meandering and it goes its way and the shrimps return to their prey.

But it might be that a little school of bass comes along, four or five or half a dozen of them, and these might follow up the first dash by pursuing the shrimps until, if they had not annihilated them, they had effectually dispersed them.—*From N. Y. Sun.*

CRIME AMONG ANIMALS.

Professor Lombroso and his disciples have long been trying to discover why, in the animal species, some are, as we classify actions, "good," and others "bad." Quite evidently there are, among the lower orders of creation as among men, certain individuals which do not seem capable of living and satisfying their wants without doing harm to their fellows. These are consequently criminals, and almost every variety of human wrong doing is to be found among them.

There are constantly cases of theft among bees. Thievish bees, to save themselves the trouble of working, attack well-stocked hives in masses, kill the inhabitants, rob the hives, and carry off the provisions. Then, having acquired a taste for robbery and violence, they form regular colonies of brigand bees.

It is a still more curious fact that these enemies to law and order can be produced artificially by giving working bees a mixture of honey and brandy to drink. They grow ill-disposed and irritable after a short course of it, and lose all desire to work. Finally, when they begin to be hungry, they attack and plunder the well-supplied hives.

In almost every dove-cote there are birds which try to obtain materials for their nests by abstracting straws that have been collected by others. These theives are not only lazy, they are untrustworthy carriers.

Murder is sometimes committed by animals; the kind of killing which has nothing to do with the struggle for life, but which arises from malice or passion. Storks often kill members of the flock which, at the time of migration, either refuse to follow them or are unable to do so. Parrots sometimes attack their companions, and crush their skulls by repeated blows of the beak, and even hens have been known to kill the feeble and lame among their chicks, and bring up only the strong.

A distinguished veterinary surgeon says that in every regiment of cavalry one may find horses which rebel against discipline, and let no opportunity escape them of doing harm either to man or to their companions. In dealing with them, it is always necessary to be on one's guard, and it is frequently imperative to separate them from the others in the stable, as they try to steal their companions' food. What is more curious still, their skulls all show a certain formation; the foreheads are narrow and retreating.

Every fact in regard to the morality of the beast, as in the case of man, goes to show how strongly actions are influenced by birth and training, and how reverent we should be in attempting to judge even our beasts of burden.—*From "The Forum."*

AFRICA'S WHITE NATIVES.

There have always been vague traditions of a white race locked up in the interior, but when the tales have come to be tested the white race generally turns out to be merely a tribe of lighter-colored Arabs, keeping all the characteristics of the race and having none of the white man's. But in this race we have something much more correct and precise.

Capt. Larymore, at present A. D. C. to Sir Francis Scott, was sent up to Koranza on a mission, and stayed a considerable time in the capital. He took advantage of the opportunity to inquire about this comparatively unknown race and its neighbors, and was surprised to find that there was an accepted tradition that there lived, an indefinite number of days' marches to the northeast, a tribe of white men. Further inquiry elicited the statement that they lived on the skirts of a desert, which was difficult and dangerous to cross. Attempts had been made to avoid this desert by passing through their country, but they were found to be so fierce and so absolutely devoid of fear that the caravans preferred the dangers of the desert to the hostility of the white tribe.

Such circumstantial statements induced Capt. Larymore to make stricter inquiries, and at length he found a Mohammedan priest and Hadji, a man of great integrity and considerable influence. He had been to Mecca, and it was on his way there and back that he actually saw with his own eyes one of this white tribe.

The man in question was armed only with a bow and arrow, but such is the reputation of fierceness possessed by the race that the caravan did not remain long in his vicinity, but left the place as quickly as possible. Al Hadji saw him distinctly. Capt. Larymore, who, by the way, is a type of the fair Saxon, interrupted the priest in his story, and said that the man must have been simply a light-colored Arab. "No," said Al Hadji, "I saw him close at hand and he had light hair and blue eyes, exactly as you have." This statement, and the confirmation it had received by many rumors and tales, was one of extreme importance, considering the strict integrity of the man who made it. Consequently, Capt. Larymore took down his testimony in writing. The existence of such a race is firmly believed in by most of the gold coast travellers, and, among others, by Sir Francis Scott.

Unfortunately, owing to the fact that the reckoning of the progress of the caravan is done in the most careless way, the spot cannot be located. Al Hadji says it is many days from Koranza, which might mean 100 or 1,000 miles.—*From the London Daily News.*

CABLE LINE TO BIG VOLCANO.

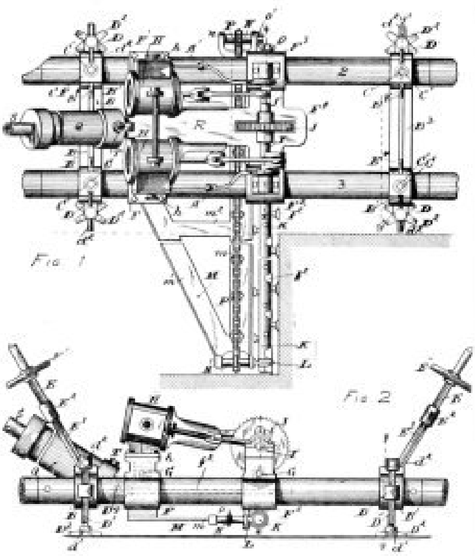
Engineers have completed the survey of the volcano Popocatepetl, for the purpose of determining the best location for an aerial cable railway to the summit. It has been determined to start the line from the ranch of Tlamacas, on the northeast, and tourists will be able to make the ascent to the summit, nearly 18,000 feet above the sea, with entire ease, and also descend into the crater, where the work of extracting sulphur is going on. The tram line will connect at the base of the cable line with the Interoceanic railroad, so that the business of shipping sulphur will be cheaply accomplished.

The drainage tunnel, now complete, measures 10,021 meters, or about six miles. The grand drainage canal, now substantially complete, measures 47 kilometers. The slopes at the sides require finishing and will be finished by next summer, and some more excavation, about 1,000,000 cubic meters, will be made, the total excavation being 11,000,000 meters.—*Exchange.*

New Inventions.

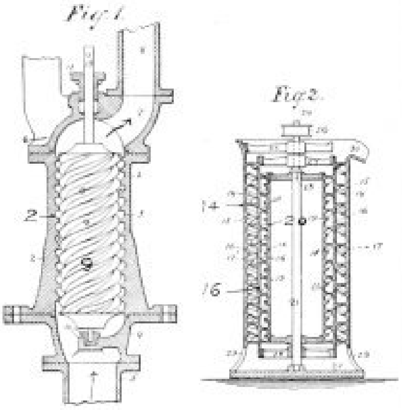
MINING MACHINE.

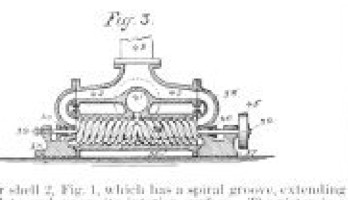
No. 551,508. Edward S. McKinlay, Denver, Colo. *Patented Dec. 17th, 1895.* Fig. 1 is a top view of the complete machine; and Fig. 2 is a side elevation of the same. The cutting is performed by a rotary bar *K* which is armed with detachable cutter bits. This bar is supported in bearings under the clamp boxes F^1, F^2, and at the outer end it is steadied and braced by the arm *M*. It is rotated by spur gearing *J*, which is driven by the engines *H*. The scraper chain *P*, is driven by means of bevel gears *O*, *O'*, from the rear end of the cutter shaft. The working parts are attached to a frame or cross-head *R*, which slides upon the guide bars 2 and 3. The machine is fed forward, upon its ways, by means of air pressure in the cylinder *Q*. This feed cylinder is attached by trunnions to the cross-girt *B*, and the piston rod is coupled to the cross-head *R*. The pressure of the cutters against the coal is thus made elastic, and of constant amount. The guide bars are tubular, and are jointed so that other sections may be joined to them, to any length desired. The cross-girts *B*, B^1, may be loosened and moved along the guide bars, and clamped fast in new positions, without withdrawing the machine from the cut, thus enabling the machine to work almost continuously.



PUMP.

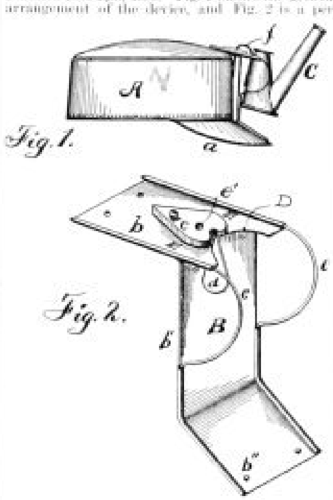
No. 551,853. Auguste Dessoffe, Odessa, Russia. *Patented Dec. 24th, 1895.* Fig. 1 is a vertical section, illustrating a simple form of the machine; Fig. 2 shows a double pump, and Fig. 3 shows a horizontal variety. The body of the pump is a circular shell 2, Fig. 1, which has a spiral groove, extending from end to end, upon its interior surface. The piston is a cylinder 9, having a similar spiral groove upon its exterior surface, but running in the reverse direction; thus, if the groove in the casing be right-handed, that in the piston will be left-handed. The most effective angle for these grooves has been found to be about 17½° between the axis of the pump and the tangent of any part of the spiral. The water is forced along in all the grooves of the case and piston, simultaneously, by revolving the piston. In Fig. 2 the piston is a hollow shell 16, having grooves upon both outside and inside. Counter grooves are formed upon the inside of the shell 14, and upon the exterior of the stationary drum 20, thus the capacity of the machine is doubled. In Fig. 3 the piston lays horizontally and has two sets of spirals which come together at the middle. Two sets of streams are thus set in motion at the same time, and the end thrust of the revolving piston against its bearings is balanced.





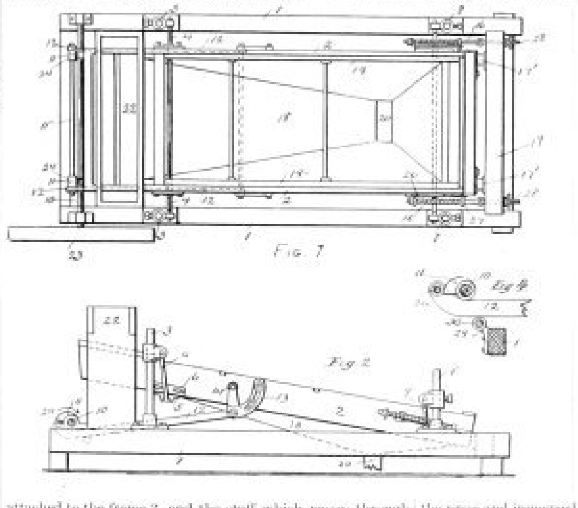
LAMP-HOLDER.

No. 551,818. Adam Good, Wilkes-Barre, Penna. *Patented Dec. 24th, 1895.* Fig. 1 shows the general arrangement of the device, and Fig. 2 is a perspective view of the holder, on a larger scale. The bracket is made of tin, in two pieces, *B* and *b*, which are stiffened along the edges with wires. A piece of leather, *e*, is riveted to the top plate *b*, and the hook of the lamp is inserted in the hole *e'*. The two wire guards *C* serve to prevent the lamp from swinging sideways, and the neck of the lamp is held steady by the curved notch *D*, in the top plate. A notch is cut in the upper part of *B*, at *d*, to allow the lamp hook to play through it, whenever the wearer of the cap stoops downward. Thus the lamp can swing forward only, and all side movement or turning is prevented.



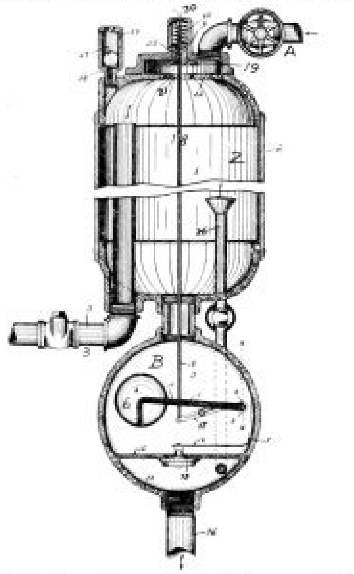
SHAKING SCREEN.

No. 552,585. Philip F. Poorbaugh, Allegheny, Penna. *Patented Jan. 7th, 1896.* Fig. 1 is a top view of the machine, the screen wires or riddle being omitted; Fig. 2 is a side view of the same; and Fig. 4 is a detail of the cam. The riddle is attached to the frame 2, and the stuff which passes through it is received in the hopper 18, and is discharged through the opening 20. The screen box 2 is suspended by swing links, 4 and 9, from collars, which can be adjusted to any height desired, upon the posts 3 and 8. The screen box is provided with bumpers 17', which strike the beam 17, when it is pulled forward by the recoil of the springs 16. The tension of these springs can be adjusted by means of the wheel nuts and eye bolts 28. The screen box is pulled back by means of cams 11, upon the rotary shaft 10, which engage rollers 24. These rollers turn on a rod 11', which ties together the pitmen rods 12. The pitmen are connected to brackets 13, which can be turned about the pivots 14. The stroke of the screen can be regulated by adjusting these brackets so that the rollers 24 are moved through a greater or less distance by the cams. The pitmen rods are supported on rollers 29, as shown in Fig. 4.



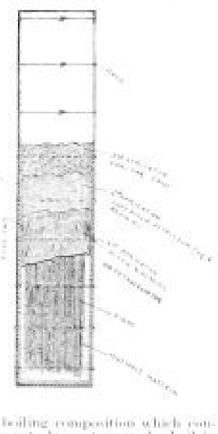
AUTOMATIC BOILER FEEDER.

No. 553,476. Orla J. Scott, Fairmount, Ind. *Patented Jan. 21st, 1896.* The tank 2 is made of any desired size. Water is supplied through the pipe 3; steam is supplied through the pipe *A*; and the water goes to the boiler by the pipe 16. The chamber *B* is comparatively small, being merely large enough to contain the float 6. A partition 12 divides this chamber into two parts, and the passage between them is controlled by the check valve 13. When the chamber *B* is full of water, the float 6 rises, and by means of lever 17 pulls down the rod 18 and thus opens a vent 20, above the steam valve 19. The steam pressure below the valve holds it up against the cover as shown, but if the vent 20 be closed by the dropping of the float, then the valve will drop and close the port 21. When 21 is closed the steam in the tank will cool and the pressure will diminish. Back pressure from the boiler will force the water remaining in the lower part of *B* up the spray pipe 26, and the spray will condense the steam, thus producing a vacuum in the tank. Water will then rush in from the feed pipe 3, and fill the apparatus. The float will rise and open the vent 20; the steam valve 19 will then lift, admitting steam above the water, and all parts will again be in equilibrium.



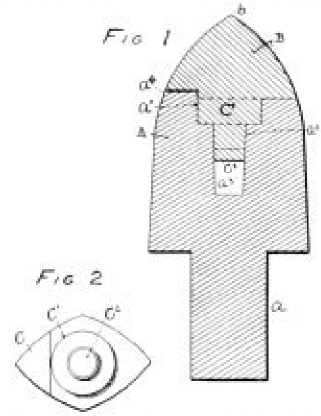
ARTIFICIAL TIMBER.

No. 553,821. Joseph H. Amies, Philadelphia, Pa. *Patented Feb. 5th, 1896.* This material is composed mainly of long coarse fibers such as sea grass, marsh reeds, salt hay, palmetto fiber, etc., which are laid parallel and with ends overlapping. They are mixed with a filling of sawdust or ground peat, and are pressed into approximate shape; the pressure being sufficient to give them a density of, say, from forty-five to seventy pounds to the cubic foot, so that the stick when completed will be sufficiently homogeneous to securely hold a nail or spike driven into it. While the fibers are still in the press they are bound with steel bands or wire, from three to eight inches apart. After having thus been compressed and bound, the article so formed is then taken from the press and immersed in a boiling composition which consists preferably of soft pitch, petroleum, tar, or dead-oil in the proportions of about one-eighth to one-twelfth of the pitch and from seven-eights to four-twelfths of the tar or dead-oil. This compound oil will penetrate the fibers to from one-eighth to one-fourth of an inch. To still further facilitate the penetration of said oil, the article is immersed in a second and heavier composition of soft pitch, petroleum, tar, and resin-oil in the proportions of about ten-twelfths pitch, one-twelfth tar, and one-twelfth resin-oil. This second composition will readily blend with the first and will cause the composition to penetrate from one to three inches. As the article thus produced would be very inflammable if left in this condition, a third application is used which causes the further penetration of the oil. This composition consists of any kind of oil which does not readily mix and blend with the former compositions—such as coal-tar, bitumen, or asphalt. This material is brought to the boiling point, a suitable quantity of sand or hydraulic cement is added thereto, and the articles are dipped and allowed to remain therein a suitable length of time. This application causes the first and second ones to penetrate very deeply. The surface of the article, while hot and gummy, is coated with dry sand and cement, which gives a surface like stone, and is very durable.



BREAKER TOOTH.

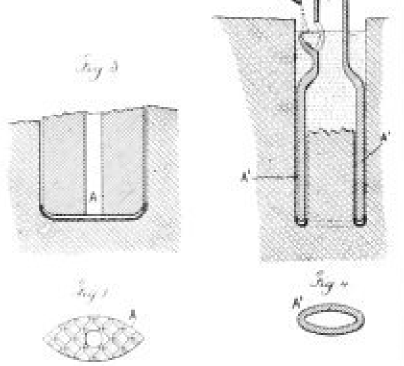
No. 550,255. George W. Cross and E. J. Touhill, Pittston, Penna. *Patented Nov. 26th, 1895.* Fig. 1 is a sectional side view; and Fig. 2 is a view of the under side of the top piece. The removable steel teeth, now commonly employed in crushing rolls for breaking coal and ores, are very expensive to maintain, because the points wear away quickly, and the removal and repair of the teeth requires much time and labor. The tooth here shown has a body and shank of tough iron or steel, and the point is made detachable. The apex is made pyramidal to suit the style of the body *A*. The top piece *B*, is attached to the body by means of a circular shank *C*, which is tightly driven into the socket a', made to suit. A tang C^2, extends downward into a transverse slot a^2. The top may be detached by driving a wedge through the slot and forcing the tang upwards. The body of the tooth *A*, is offset vertically at a^4, to suit a corresponding shoulder on *B*. The top, or point, is thus prevented from turning.



DRILLING STONE.

No. 553,307. George M. Githens, Brooklyn, N. Y. *Patented Jan. 21st, 1896.* Fig. 1 is an end view of an oval drill having a flat end and rounded edges as shown in Fig. 3. The face is scored with shallow grooves as shown. Fig. 2 is a section through a tubular drill, also of oval form, as shown in Fig. 4. These drills operate by percussion in the ordinary manner, but the drilling operation is aided greatly by the use of steel shot and similar abrasive material under the face of the drill.

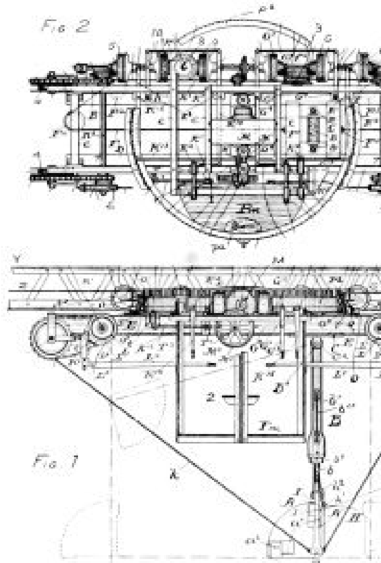
The stem *B* of the drill is of any suitable character and connected to the head of the drill by welding or otherwise, and at *C* is represented a water supply, and at *D* a means for supplying into the hole granular material—such as small pieces of hard steel, sand or other suitable substances—to be carried into the drill hole by the action of the water, and as the drill is reciprocated, the granular material intervening between the sides of the drill and the interior of the bore, the hole is enlarged sufficiently around the drill to allow the same to play freely without the risk of binding or wedging into the hole, and the granular material intervening between the end of the drill and the surface of the rock is driven into the rock by the concussion, and the water being present the particles of granular material are alternately loosened and driven into the rock in such a way as to abrade the rock with rapidity, and the pulverulent material is washed out by the action of the water; and when small pieces of steel are made use of, their gravity is usually sufficient to cause them to remain at or near the bottom portion of the hole until they are no longer useful for the purposes aforesaid.



It will be observed that as the drill approaches the bottom of the hole the particles of steel or similar material intervening between the drill and the stone are driven outwardly by the rounding portions of the edges, before the force of the blow is finally expended in driving such particles against the bottom of the hole. Hence the first portion of the blow is really expended in enlarging the hole so as to make the drill run freely. It is advantageous to score the face of the drill with comparatively shallow grooves or channels, which may be parallel or crossing each other, and these grooves promote the rapidity of operation in consequence of concentrating the force of the blow upon some of the particles of steel more than upon others, thus producing a movement between the particles themselves as they lie upon the bottom of the drill hole, and preventing such particles of steel or other material becoming packed and hard. Only a small quantity of such granular material is to be supplied from time to time, because too much of such granular material would interfere with the operation of the drill.

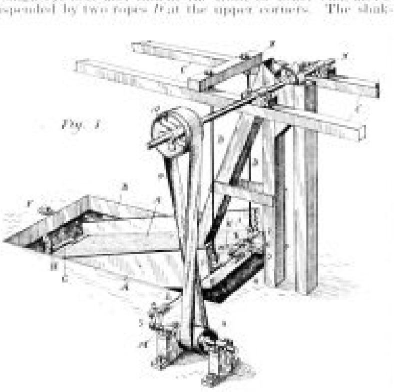
COAL HANDLING APPARATUS.

No. 553,082. Richard Tiehe, Cleveland, Ohio. *Patented Jan. 12th, 1896.* Fig. 1 is a side view, and Fig. 2 is a top view. This apparatus consists of a scoop or shovel *A*, which is suspended from a swinging arm *R*, and a sliding trolley *C*. The scoop is constructed to operate with either edge down, forward or back, and is provided with a suitable latch b^2, which can be released by means of a chain, from the operator's seat 2. The trolley slides upon the flanges of the beams *E*, and is moved back and forth by means of a rope *F*, drum 3, and clutches *G* G^2. The scoop is swung by four ropes, two at the front and two at the back. These are wound on drums 4, which are driven by sprocket chains from the clutches 5 and 6, by the shafts 7 and the bevel gears shown. Each shaft 7 is provided with a brake wheel *L*. The beams *E* are fastened to a large center ring, which turns on balls within a similar ring P^2. This ring is provided with an internal gear which engages the vertical pinion 8. The gear ring forms a large drum, around which a small cable is wound two or three times, and this cable *Z* extends to the ends of the runway or bridge *Y*. The stationary center ring is attached to a large trolley *N'*, which runs on suitable wheels upon the lower flanges of the runways *Y*. The pinion 8 is rotated by the clutches 9 and 10. When the gear ring is fastened to the trolley *N'* by a suitable locking pin, the shoveling apparatus can be turned in any direction by rotating the pinion 8; but when the beams *E* are locked to the trolley *N'*, then the gear ring will turn and operate as a large pulley, and the entire apparatus will be drawn along upon the runways by means of the standing cables *Z*. All of the clutch levers and latch handles are within reach of the operator's seat. Power is applied by means of an electric motor *M*, and the gearing shown.



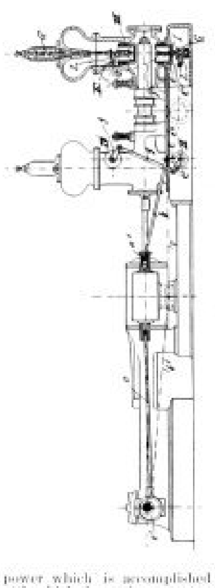
SHAKING SCREEN.

No. 553,360. W. D. Richardson and G. J. Holl, Cleveland, Ohio. *Patented Jan. 21st, 1896.* The screen is hung by a single eye bolt and link at the front or lower end, and is suspended by two ropes *B* at the upper corners. The shaking motion is imparted by means of a crank 5 and pitman *L*. The connection to the screen at 4 is a universal joint. The motion given to the screen is mainly lateral, being greatest at the head of the screen, where the material is supplied, diminishing to very little at the delivery end.



VALVE GEAR FOR PUMPS.

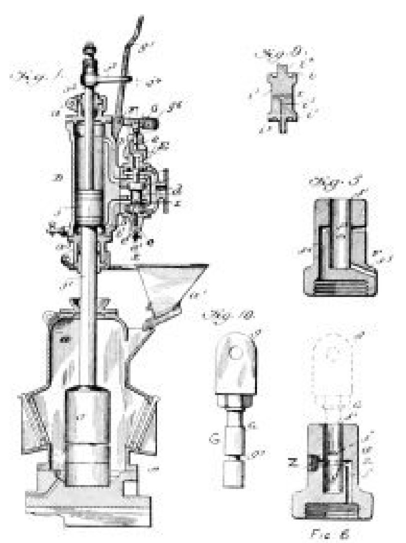
No. 553,878. John Stumpf, Charlottenburg, Germany. *Patented Feb. 4th, 1896.* This gear is designed to open the suction and discharge valves of a pump, by positive mechanical devices, and to allow them to be closed by springs and gravity. In the pump here shown the pump valves are operated by the same eccentric which moves the steam valves. Consequently the discharge valve is opened a little before the plunger reaches the end of the suction stroke; and on the forcing side, the suction valve is opened a little before the completion of the forcing stroke. In other words, the pump valves have about the same "lead" that is given to the steam valves. It is claimed that by letting in the pressure from the column, near the end of the suction stroke, the engine turns the centers easily, and the water barrel is filled with solid water, so that the return stroke is made without shock. This arrangement reduces the capacity of the pump somewhat, but it is claimed that the loss is overbalanced by the saving in power which is accomplished thereby, and the smoothness with which the engine operates.



STEAM ORE STAMP.

No. 553,291. Albert F. L. Reussner, Jersey City, N. J. *Patented Jan. 21st, 1896.* Fig. 1 is a vertical section of the complete machine. Figs. 5 and 6 are sections of the primary valve chamber. Fig. 10 is the primary valve, and Fig. 9 is a section of the main steam valve.

The main valve *I* is operated by means of a primary valve *G*, which is operated in one direction by the main piston rod, and in the reverse direction by a weight g^6. The main valve has a plunger rod at each end, the one at the top having about twice the area of the lower one, and these work in suitable cylinders formed in the ends of the steam chest. Steam is received at the middle port, and the exhaust goes off through the outlet *d*. As shown in Fig. 9, there is a hole in the valve *I*, which admits steam to the lower end *e* of the



lower plunger constantly. Steam is admitted or released from the end of the upper plunger by means of the primary valve *G*. Steam is supplied to this valve by a small pipe which enters the casing at *Z*. f^3 is the exhaust port. When the piston rises, the cam roller j^3 encounters the part g^5 of the lever, and lifts the valve *G*, so that the exhaust port is opened to the upper plunger of the main valve. The steam pressure on the lower plunger instantly raises the main valve and gives steam to the top of the cylinder. The piston makes a full stroke, steam following to the end of the stroke and giving a dead blow. The main valve, however, is not reversed until the weight g^6 pushes down the primary valve and gives steam to the top plunger. Being larger in area than the lower plunger, the steam pressure drives the main valve downward and gives steam to the under side of the main piston. The movement of the main valve being comparatively slow, the main piston will always make its full stroke downward before the steam pressure is reversed.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 10. SCRANTON, PA., MAY, 1896. With Which is Combined THE MINING HERALD.

PLACER MINING.

A GENERAL AND SPECIFIC ACCOUNT

Of Placers, Their Formation, Distribution and the Construction and Development of the Different Machinery and Devices Used in Working Them.

Written for The Colliery Engineer and Metal Miner by Prof. Arthur Lakes.

To the glaciers of past and present time we mainly are indebted, not only for our placer deposits, but also for a large proportion of our workable mines. Glaciers were the pioneer miners on a broad and liberal scale, after them the rivers, and in a minor degree the waves of the sea.

Fig. 1.—Part of Witwatersrand Gold Basin, South Africa.

1, Granite; 2, Basalt; 3, Sheets of Volcanic Mud; 5, Slate; 6, Shale; 7, Quartzite; 8, Sandstones and Conglomerates; 10, Magnetic Quartzite; 11, Limestone; 15, Quartzite, Black Reef series.

Imagine if we can the mountains of the world without erosion. They would be vast, smooth, rolling waves of strata, occasionally broken by stupendous cliffs, the results of profound faulting. As mineral veins are due in most cases to the action of hot springs, geysers, etc., we should see here and there on such lines of fault fissure, smooth mounds of "tufa," like those built up by the hot springs and geysers of the Yellowstone Park. Some of these geysers might still perhaps be in action, as at Steamboat Springs, Nevada, where veins are already made, and others in actual process of formation. Not a mineral vein would appear exposed as we see them now. We should have to burrow deep down into the conduits of these springs to find them. Other regions would present blackened plains of horrible unbroken lava, with here and there, perhaps, hot and gaseous springs in action, or as before, tufa mounds spotted over the dreary landscape on lines of buried fissure. Such would have been the aspect of Cripple Creek and the great San Juan region in early times. On such an uneroded country let the glaciers be set to work. See them filling up every incipient ravine or rolling valley caused by undulations of the strata beneath. The ice sheet planes off the tops of mountains, and exposes the rings of strata of which it is composed, and the spring-formed veins—as we cut off the top of a water melon and expose its rings of fruit-like growth and seeds. The ice tongues or glaciers descending from the sheet cut long U shaped swaths down the sides of the hills and by mighty canyons expose the ribs and anatomy of the mountains and the strata and the gold veins they contain. The debris of this planing is distributed in windrows on the sides of the canyons and bottoms of the ravines, to be winnowed and sorted by subsequent streams and rivers, and to be carried out and distributed also over the plains as soil for the farmer, and to the ocean to form beaches and sea bottoms to be upheaved hereafter to form future continents and future mountains. If all the gold that has been spread far and wide in minute grains by these media could be collected, it would far exceed all that is or ever will be obtained by man's puny efforts at vein or placer mining.

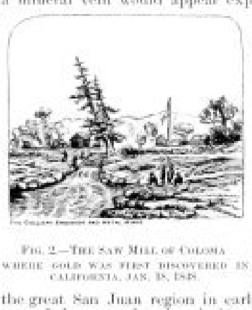


Fig. 2.—The Saw Mill of Coloma where Gold was first discovered in California, Jan. 18, 1848.

We must not suppose that all this gold distributed over the world and found more or less in nearly every stream, is derived exclusively from distinct gold-bearing fissure veins, but rather from the general breaking up of vast masses of crystalline rocks, such as granites, porphyries, and lavas, which are known to contain gold more or less distributed in minute particles throughout their mass.

VERY ANCIENT CONSOLIDATED PLACERS.

Though placer deposits are generally conceded to have been laid down by comparatively recent glaciers and streams in loose incoherent banks, yet there are other and far older formations, not generally included under the name of placers, which still have had much the same aqueous origin, and are withal gold-bearing. We do not refer to the "deep leads" or placers of hard conglomerate overlain by a protective cap of somewhat recent lava as in California and Australia, whose origin is obvious, but to beds of hard uptilted conglomerate sandstones, such as those worked at Leydenberg, in the Transvaal of South Africa. See Fig 1. These are but ancient consolidated placers or ancient river and sea beaches consolidated by time, heat and pressure into hard rock and thrown up nearly to verticality in the forms we in Colorado should call "Hog-backs."

Fig. 3.—Primitive Mining, the Old Rocker.

The Homestake mine in the Black Hills derives its gold from a hard consolidated placer of Cambrian age, and we believe and even know that gold may be found in many of the ancient coarse conglomerate rocks if looked for, and in cases they might be profitable if they could be worked wholesale by some cheap process.

GLACIATED REGIONS THE HOME OF PLACERS.

Since glaciers are the parents of placer deposits, we must look for such deposits principally in those northern and mountainous regions which have been most glaciated, such as Alaska, for instance, with its coast line torn into tatters, and its mountains cloven through and through by modern and ancient glaciers, and by a network of small and great streams, originating from them. So down the Pacific Coast to Southern California, along the lines of the Sierra and coast ranges, in British Columbia, Idaho, and Washington territory, in all these, the glacial placer deposits are to be estimated at hundreds of feet in thickness, whilst as we proceed inland to the Rocky Mountain range and retreat from the main centres and zones of glaciation the deposits grow less in size and thickness.

HISTORY OF PLACER MINING.

Gold washing of alluvial deposits has, both in ancient and modern times, preceded vein mining. In modern times placers have led up to the discovery of veins in place, but in ancient times it was all gold washing, and

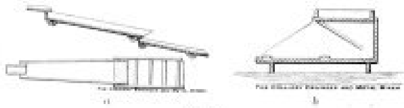


Fig. 4.

a, Plan and Section of Long Tom Sluice; b, Section of Rocker.

if by accident they found gold veins, they do not seem to have understood their value, or what to do with them. Nor is this greatly to be wondered at, seeing that in quartz veins gold very rarely shows itself on the surface and commonly not at all throughout the vein. The gold we read of in the ancient world was all derived from the sands of streams.

Fig. 5.—The First Attempt at Hydraulicking.

In recent articles we have told of the widespread distributions of gold in placers all over the world including Canada, Alaska and the northwestern part of the United States.

There are also extensive placer grounds in New Mexico along the Rio Grande river between the Sangre de Cristo and Continental divide. There is difficulty at times of bringing water to bear. The bed of the Rio Grande is a placer being worked by dredges. The discovery of gold at Coloma near Sutter's Fort, California, on January 18, 1848, by James W. Marshall is a trite story. Marshall while digging a race for a saw mill at Coloma, thirty miles east of Sutter's Fort, found some pieces of yellow metal which he supposed might be gold. Knowing nothing of chemistry or gold mining he could not prove the nature of his find, so his collection of specimens continued to accumulate. In February a man named Bennett employed in the mill went to San

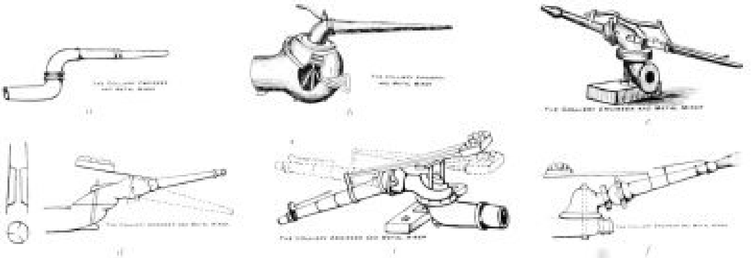


Fig. 6.—Evolution of the Giant.
a, Goose Neck; b, Craig's Globe Monitor; c, Hydraulic Chief; d, The Little Giant; e, Hydraulic Giant; f, Monitor Hydraulic Machine.

Francisco and returned with a man named Humphreys who had washed gold in Georgia and he declared the deposits richer than in his own state. By a rocker he obtained daily about an ounce of gold and soon all the mill hands were rocking for the precious metal.

Pierson Redding, a ranch man from Sacramento, visited Coloma and resolved to try the deposits about his own farm and opened a bar on Clear creek. John Bidwell followed suit on Feather river. So the work

Fig. 7.—Deep Lead Mining by Underground Sluice.

grew till on the cession of California in 1848 to the United States, miners were at work on every large stream on the western slope of the Sierra Nevada from Feather river to Tuolumne, 150 miles. The first printed notice of the discovery of gold was in the "Californian" newspaper, published in San Francisco, on March 15, 1848. On May 29 the paper suspended, as the whole force, together with the population, had gone to the mines. In 1849 the placers of Trinity and Mariposa and in 1850 those of Klamath and Scott's Valley were discovered. Water being a great desideratum, the first attempt at a ditch of any size was in March, 1850, at Coyote Hill, Nevada Co. In 1850, 50,000 men were placer mining in California.

At first it was all pick and shovel, rocker and pan. Then the Long Tom sluice box was introduced. Work on dry bars led to mining the river bottoms by wing dams. Later, entire streams were turned from their course by flumes and ditches. From the shallow placers the miners pushed back to the deep deposits worked by Long Toms and sluices. As the deep deposits of gravel were poorer than the shallow placers, open cuts were necessary and a larger supply of water originated the use of sluices.

Sluices ran dirt faster than shovellers could supply it. Edward Mattison of Connecticut used a stream of water under pressure conveyed in a rawhide hose and discharged through a wooden nozzle against the bank. So the earth was torn from the bank and carried into sluices, dispensing with shoveling. Thus began hydraulic mining.

EVOLUTION OF THE GIANT.

The evolution of the nozzle and discharge pipe is interesting. It commenced by using a simple canvas hose with an iron or tin nozzle; then a flexible iron joint, formed by two elbows, one working over the other, with a coupling joint between them, was invented. These elbows were called goose necks. (See a, Fig. 6.) But pressure caused the joint to move hard and the pipe when turned in a contrary direction "bucked."

This led to the Craig Globe Monitor (b, Fig. 6) a simple ball and socket joint, but hard to manage. Later Craig's interior tripod and a bolt were used, a tripod with center having a hole to take a bolt with knob in the end. The other end passed through the top of the elbows and had a nut with lever. Tightening the nut threw the strain on the bolt reducing friction on the joint proper; these were unwieldy and leaked at joints. The hydraulic chief followed, a knuckle joint and nozzle with two elbows placed in reverse position when in right line, connected by a ring in which are anti-friction rollers (c, Fig. 6). The ring is bolted to the flange on the elbow, but gives the upper elbow free horizontal movement, while vertical motion is obtained through a knuckle joint placed in the outlet on the top elbow. This joint is a concave surface fitted to a convex one, the former having an opening for the pipe to pass through. The interior is unobstructed by bolts, and the man at the pipe operates it by a lever. Vanes or riffles are inserted in the discharge pipe, to prevent a rotary movement of the water caused by the elbows, and to force it to issue in a straight concentrated and solid form. Hoskins' Dictator in 1878 was a one-jointed machine with elastic packing on the joint instead of two metal faces. The joint worked up and down on pivots, and rotating wheels ran around up against the flange. The "Little Giant" was a two jointed machine simple and durable with knuckle joint and lateral movement (d, Fig. 6). It has riffles and nozzles 4 inches to 9 inches diameter; five and one-half to 7 inches in nozzles and is commonly used. Giants must be firmly bolted to heavy pieces of timber braced against solid rock or gravel. The Hydraulic Giant (e, Fig. 6) is a modification of the Little Monitor with deflecting nozzle (f, Fig. 6) and the deflector, which is worked by a deflecting nozzle can be turned to any point.

Drift mining began in 1852 in the old river channels. Deep tunnels were due to a discovery on Table Mt. of gold gravel lying in channels under the mountain. After overcoming difficulties from a surplus of water, they were rewarded by in some cases finding 10 square superficial feet to yield $100,000, and it is said that on one occasion a pint of gravel produced a pound of gold. In 1853 there was a rush to the Comstock. Hydraulic mining and the working of old river deposits gained steadily from 1852, and forty-inch wrought iron pipes and masses of water discharged through nine-inch nozzles under 450 feet pressure were substituted for canvas hose and stove pipe and one-inch streams.

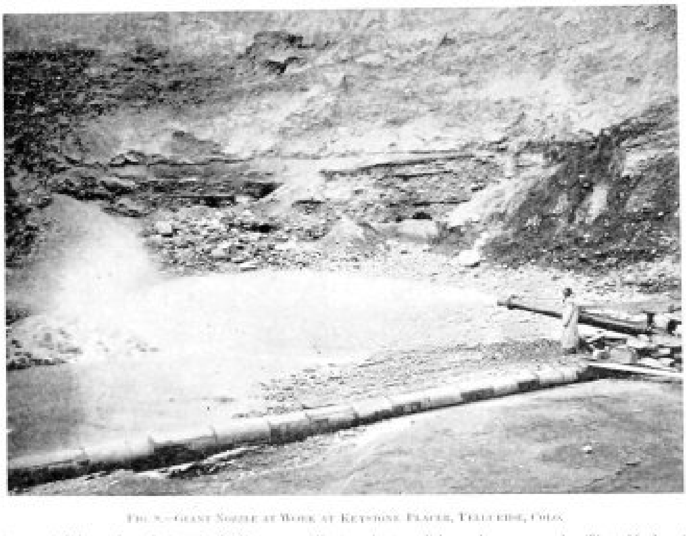


Fig. 8.—Giant Nozzle at Work at Keystone Placer, Telluride, Colo.

GEOLOGY OF CALIFORNIA PLACERS.

California is divided into four parallel lines or three great belts, consisting of the Sierras, Great Central Valley of California, and the Coast ranges. The Sierras of granite and igneous rock are the main source of the old river gravels. The Great Central Valley is the main belt of recent and alluvial placer deposits. Gold veins occur mostly in slates, both in Sierras and Coast ranges. The country covered by lava flows is in Trinity, Plumas and Butte, with Lassens and Shasta Peaks. Streams flowed from the latter over North California and Oregon and covered up some of the placer deposits of glacier and river. The gold area is limited north, not by thinning out of deposits, but by thickening of lava.

The old rivers eroded the slates with thin gold quartz veins and deposited the debris in beds from a few inches to 600 feet deep. Lava several hundred feet deep covers these in places. Fossil wood and leaf impressions and bones of land and water animals, together with

Fig. 9.—Caving Placer Banks in California.

elephant remains, and even the bones and implements of prehistoric man, are found, as in the case of the celebrated Pliocene skull of Calaveras county.

The following may be taken as a typical section of a placer at New Kelly as given in Bowie's manual of hydraulicking.

	Ft.
Top red sand	1
Coarse red gravel	6
Red cement (hard pan)	6
White sandy clay	0.8
Red cement (hard pan)	2
Sand and pebbles	6
Loose yellow sand	7
Dark gravel of granite, slate, porphyry, serpentine and quartz	13
	42.8

The greater part of the gold is found here, as elsewhere, in the lower strata of gravel and on bedrock associated with magnetite or black sand and some platinum. Gold is rarely disseminated through the beds. Sometimes it occurs in the upper alluvial portion in streaks of cemented gravel, but if this is of fine clay it is liable to be barren. Some gold is occasionally found at grass roots. Pay gravel may occur high above bedrock, but generally in the coarse material near bedrock and on the bedrock itself and in its crevices. The latter has often been dug up for some depth before all the gold in it was exhausted. In California and Australia these placer deposits are sometimes covered with lava but rarely so in other regions.

DIFFERENT KINDS OF PLACER DEPOSITS.

Shallow placers are deposits a few feet deep as distinct from deep placers several hundred feet deep. Hill claims are deposits on hill sides by glaciers or old extinct streams. Gulch diggings are in gulches and flat de-

Fig. 10.—High Placer Banks Worked in Benches, California.

posits on plains and flats. "Bar claims" are bars of gravel on sides of streams above water level. Beach sands are gold-bearing sands of the seashore largely consisting of grains of magnetite served up in windrows by the tide. Dry washing was practiced by Mexicans where water was scarce and deposits rich. After pulverizing and drying the richest they worked it in a wooden bowl or "batea." The earthy portions, by circular motion given the disc, were separated from the gold which was extracted by winnowing. Ground sluicing consists in treating the gravel excavated by pick and shovel by washing it in trenches cut in bedrock, the natural rock serving the place of riffles. Booming is by damming up a stream perhaps at a high level or forming a reservoir and then letting the water suddenly go. The rush carries off the big boulders and some gold into sluices leaving the heavy gold and black sand collected on bedrock floors. We remember a successful case of this booming in the San Juan district. Prospectors had for a long time observed and picked up very rich float on the slope of a steep mountain covered with loose debris but had failed in locating the vein or source whence it came. At the top of this mountain was a small lake fed by a stream. The miners dammed up one end of this lake till it was full then they cut through the dam and "let her go." The water rushed down the slope carrying debris before it and quickly cut a channel to bedrock and exposed the long looked for vein.

In deep mining for deep placer leads there are two methods, "drifting" and hydraulicking. In drifting the gold is mined in deep deposits by tunnels, (see Fig. 7) especially where these deposits are covered by lava and the the gold is concentrated in a well-defined layer or channel. In some claims shafts are sunk and gravel drifted out and raised to the surface. Drifts are run out on either side the shafts. Gravel, when too firmly cemented, is crushed in stamps.

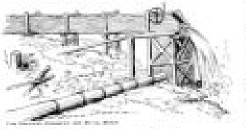


Fig. 11.—Head Box.

Hydraulicking is the best way for working deep deposits. For profit there should be ample facilities for grade and dump, and sufficient head and plenty of water. Miners in early days soon exhausted the bars above water level and turned their attention to deposits lying under water. Streams were dammed and sometimes turned into new channels at great cost. Beds of rivers in this way were laid bare as at Roscoe, Clear creek, Colorado, described in past numbers of the Colliery Engineer and Metal Miner, and claims were worked on the parts exposed. In this large scale of mining both losses and gains were enormous. To avoid turning rivers from their courses, dredging machines were built and used, as at present on the sands of the Rio Grande river in New Mexico, and tunneling under the surface of the river to get down to bed rock was contemplated. Hydraulicking is one of the best methods, though it employs twice the number of men that drifting does, yet it extracts four to six times the gold per lineal foot of channel. One mine by drifting took out $1.50 per foot, while hydraulicking the entire deposit yielded $7.50 per foot, according to Bowie. (See example of a placer bank and hydraulicking, Fig. 8).

MODE OF WORKING PLACERS.

After the flume and sluices are finished, water is turned into the pipes and washing commences. Sluices are run half a day to pack them. Water is then shut off and a charge of quicksilver put into the upper 200 or 300 feet of sluices. A small quantity is distributed along the entire line except the last 400 feet. In a six foot sluice, the first charge is three flasks of quicksilver. Undercurrents are charged at the same time, and a little quicksilver in the tail sluice. Quicksilver is added daily during the run in lessening quantities, the object being to keep the mercury uncovered and clear at the top of the riffles. So the charge is regulated by amount exposed to view. At North Bloomfield, Cal., the main sluice is cleaned up every twelve days. Eighteen flasks of quicksilver are used in a run. A 24 feet undercurrent takes 80 pounds of quicksilver. In charging riffles avoid splashing the quicksilver, as it divides itself into minute particles which are carried off by a swift stream or float off in clear water. So buoyant is quicksilver that it has been taken from the surface, containing particles of gold, 20 miles below where it was thrown in. At Roscoe we found plenty of quicksilver that had come

Fig. 12.—Ground Sluicing.

down from the stamp mills of Central, 20 miles distant.

Our readers will remember our description of the progress of the work at Alma, which appeared in the December, 1895, issue of the Colliery Engineer and Metal Miner, to which we refer them. The following additional note, we add from Bowie's manual, to whose excellent work on hydraulicking we are indebted for much of the material in these articles: The first work is started near the head of the sluice and the mine opened from that point. As banks are washed away bed rock cuts are driven towards the face of the work and sluices are advanced. To "cave" a bank two pipes are used, throwing streams from opposite sides forming a cross fire against the lower part of the bank (see Fig. 9). When washing with two pipes, and the dirt caves readily, one pipe should do the cutting, and the other wash the falling gravel into the ground sluices. The face of the bank should be kept square and a horseshoe form avoided. When a cut is pushed ahead and work not squared, men at the pipes are encircled by *high banks* and washing can no longer advantageously progress, and lives are endangered. Banks over 150 feet high should be washed in two benches (see Fig. 10). When the banks are about to cave, water should be turned away from falling masses. If the cave falls upon the water in the ground cut, a rush of debris ensues, and men at the pipe have to run for their lives. Caves are made in the evening the night shift running them off. Locomotive reflectors, bonfires or electric lights illumine the works at night. Washing should be continuous and no water go to waste, so several faces should be kept so that water can be used from time to time whilst cuts are being advanced and sluices lengthened.

These ground sluices (Figs. 12 and 13) are trenches in bed-rock toward the face of the bank washed, to collect water and materials and convey them to the sluices. Sometimes these cuts are 60 feet deep; sluices are run full of gravel before turning off the water. The length of runs may depend on the wear of the pavement. Some claims are cleaned up every 20 days, others in two or three months, others only once a season. Pavements should be cleaned up as soon as they wear in grooves. Where there is much water and ground, the clean up of first 1,000 feet paved with rocks, is every fortnight; tail sluices, once a year; undercurrents, when quicksilver is found spread over their ends. In cleaning up, bed-rock and cuts are piped clean, then only a small head of water is turned through the sluice. Blocks are taken out with bars, washed free of amalgam and laid by the

Fig. 13.—Bedrock Flume.

side of the sluice. This is done in sections of 100 feet. Between each section one row of blocks is left in the sluice. These rows prevent gold and quicksilver passing down the sluice. After the first section of blocks is taken up, men follow the gravel as it is slowly washed down the sluices and pick up quicksilver and amalgam with iron scoops and put it into sheet iron buckets. As each riffle is reached amalgan and quicksilver are collected, block riffles removed, and residue washed down to next riffle and so on down the sluice.

Water is then turned off, workmen attend to nail holes and cracks in sluices, "crevicing" them with silver spoons, to obtain amalgan. Side lagging is overhauled, and blocks replaced. In very long sluices the lower portions are lined with heavy rock, used for longer periods without cleaning. In very long sluices run at night, they clean up during the day as long a section as possible, and put it in order for further work, resuming washing at night, until the whole is cleaned up. In cleaning up sluices, 80 per cent. of the gold caught is found in the first 200 feet. Lessening of grades and use of undercurrents tend to diminish the loss of fine gold. Of the methods of retorting the gold from the amalgam we have spoken before.

Demand for water caused thousands of miles of ditches to be made in California. The immense cost was repaid, however. From the rugged character of the country, steep grades were used and high trestles supporting flumes at 200 feet. Wrought iron pipes carried water across canyons.

In locating a ditch the following points are to be observed: First, source of supply at sufficient elevation to cover the greatest range of mining ground and to give greatest pressure; second, abundant summer supply; third, water courses on line of ditch secured to add to supply; fourth, waste gate, at intervals not greater than half a mile; fifth, ditches preferred to flumes.

In surveying, the barometer is used to determine elevations of termini and intermediate points. The lines are staked out and bench marks placed every half mile. Size of ditch is regulated by its requirements. The form may be rectangular, trapezoidal, circular or square. Rectangular profile gives least friction. In mountainous districts narrow deep ditches with steep grade are preferable. In California, ditches with 80 cubic feet capacity per second and grades of 20 feet per mile are operated. Banks of solid untouched gravel are preferable to made banks. Large ditches may have a slope of 60° for upper and 65° for lower banks. Wooden flumes are set on grades of 25 feet per mile. They are made of 1½" pine planking, 12" to 24" wide and 12' long. At joining of boards, pine battens, 3 to 4 inches wide and ½ inch thick cover the seam. Sills, posts and caps are placed at every four feet. A flume 2½ feet square requires 3x4" scantling for posts and 4x6" for stringers. Posts should be set into caps and sills with jar of ¼" and not mortised. Sills extend beyond posts. Curves should be laid with care to ensure maximum flow of water. Boxes are cut in two, three and four parts. For good curving of

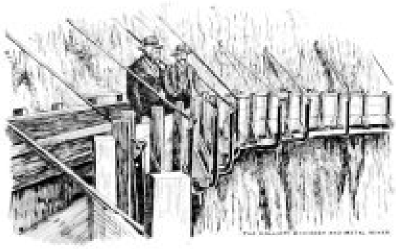


Fig. 14.—Method of Hanging Flume to Cliff by Iron Brackets.

side planks they are sawed partially through in places to bend easily. To avoid slack water, irregular currents, splashing, etc., the outer side is raised in accordance with curve. Waste gates are placed every half mile. In snowy regions it is difficult to keep flumes and ditches open during severe weather from anchor-ice forming on the bottom. When this happens water should be turned out. Freezing is often avoided by setting the flume in close to the bank. In building a line of flume, the bed being prepared, stringers are put in place, sills laid on them 4 feet apart, bottom planks are nailed to sills, and side planks to bottom planks and posts. Boxes set on grade are held in position by wedges. A flume rarely lasts twenty years. Flumes along cliffs are supported by brackets made of iron rails bent in an L shape (Fig. 14).

Iron pipes crossing large depressions are called inverted siphons. A supply pipe conveys water from pressure box to claim. Distributing pipes take water from distributor or gates at end of supply pipe and deliver it to discharge pipe or nozzle. Thickness of iron depends on pressure of water and diameter of pipe. Pipes may be 11, 15, 22 to 40 inches diameter. Air valves are provided in a long pipe for escape of air from the pipe.

The pressure box is at the end of the ditch above the claim, and from it water is delivered into the supply pipe. See Fig. 11. The sand box forms part of the pressure box, sunk below the level of the flume, arranged to catch gravel or sand carried by the current. The pressure box is a large wooden receptacle, deep and large enough to keep the head of the pipe entering it under water with steady pressure. A grating of bars catches floating matter. For 22-inch pipe, No. 14 B. G. is the lightest iron used. The main pipe should descend in as direct a line as possible to the diggings. At all angles the pipe is braced and weighted. Leakage is stopped with sawdust in slip joints. Branch pipes are smaller in diameter.

TUNNELS.

Tunnels are used to open gravel claims, where open cuts cannot be made, and to afford facilities for conveying washed material. A tunnel should be driven well into the channel before connection is made with the surface. A shaft connecting headings should be vertical and about 3 x 3 feet wide. Shafts are the best way for opening up hydraulic claims. In loose gravel, timbering is necessary. The size of tunnel depends on size of sluice, usually two or three feet wider than inside width

Fig. 15.—Block Riffles.

of sluice and 8 feet high. Locate the tunnel mouth at that point from which sluices running in a given grade can bottom the maximum extent of the pay channel.

SLUICES.

Sluice originally meant "sluice box"; when sluice boxes were joined together it was called a flume. Sluices should be as much as possible in straight lines. Where curves occur the outer side of the box should be slightly raised like a railroad curve, to cause more general distribution of material over the riffles. With frequent curves and long lines of sluices the grade is increased, and sluices with drops are desirable for saving gold. Movement of gravel depends on grade of sluices. Coarse wash or hard cement or much clay require heavy grades, and cemented gravel requires drops to break it up. A six and a half inch grade to a box six feet long is recommended.

By using too much water, masses of black sand are apt by the overlying pressure to pack the riffles. Shallow streams require a light grade. In washing heavy material the water in a sluice should be deep enough to cover the largest boulder generally sent down. As a larger body of water is sent through a sluice running heavy cement gravel, more material can be transported by a proper proportion of light and heavy gravel mixed. Size of sluice depends on grade, character of gravel, quantity of water. A sluice 6 feet wide, 36 inches deep, on a 4 per cent. grade, is enough for running 2,000 to 3,000 inches of water; one 3 feet wide, 30 inches deep, at 1½ per cent. grade, for 1,000 inches. Extend the sluice as long as yield exceeds expense. Sluices 4 feet wide are made of 1½ or 2 inch plank with sills and posts of 4 x 4 inch scantling. The bottom should be made of half-

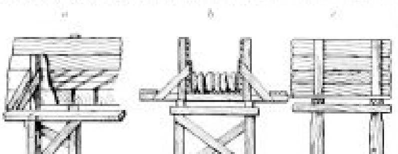


Fig. 16.

a, Squared Block Riffles; b, Stone Riffles; c, Side of Flume.

seasoned lumber free from knots, jointed and grooved, with soft pine tongue inserted; bottom and sides are spiked together, sills placed 4 feet apart, posts halved into the sills, spiked and angle-braced. The flume should be heavily weighted down by loading the ends of sills with stones.

RIFFLES.

Riffles date back to the earliest days of gold-washing. Blankets, hides with hair uppermost, reeds and grass sods were used; also slips cut in the bedrock. Wooden blocks and rocks are now used. Scale gold associated with much black sand or pyrites escapes riffles for long distances. Block riffles are square wooden blocks 8 to 13 inches deep set on end in rows across the bottom of the sluice, each row separated by a space of 1'' to 1½''. They are kept in position by riffle strips 1½'' thick and 2'' wide held crosswise on the bottom between rows by pine wedges driven between blocks and sides of sluice. A side lining is required in sluices. In cement claims blocks 3'' thick covering 18'' to 20'' (in depth) of the side are used for side lining. At Alma, South Park, Colo., the riffles are made of the round sections of trunks of pine trees laid down like a "Nicholson" pavement, the interstices filled with small stones. Cobblestones or rocks are sometimes used for sluices with steep grades and abundant water. Wood such as pitch pine, which is long-grained and "brooms up," makes the best riffles. The wear on riffles by heavy stones and gravel pounding on them is considerable. Block riffles after much use are often found to carry a certain amount of gold in them, which is obtained by burning the old, used-up riffle. After each run the blocks are turned and replaced in the sluice. In repairing with old blocks the edge worn down most is placed up stream. Both blocks and rocks are sometimes used together on alternate rows, which reduces the wear and tear of the blocks. Sometimes bedrock itself is a sufficient riffle. In dumping, the "turn out" rather than the "turn in" sluice is used when the dumping ground is limited.

UNDERCURRENT SLUICES.

To relieve sluices of finer material and aid in saving the gold, "undercurrent" sluices are introduced into the sluice line, such as we described in the Roscoe placer. The following additional notes from Bowie's Manual may be useful on this subject: "Undercurrent sluices are broad sluices set on heavy grade at side of and below the main sluice. Where a drop-off can be made on the main line, parallel steel or iron bars 1x4'', with intervals of 1'' between, and 10 to 20 in number, according to size of undercurrent, are placed edgewise across the sluice. This is called a grizzly. It is set 1'' below the sluice pavement. Coarse material passes over the grizzly, and is dropped and picked up again in sluices at a lower level. Finer gravel drops through the bars into a box 20'' deep lined with blocks set at right angles to the main line. This box carries the material to the sluice at the upper end of the undercurrent. It has a 2 to 3 per cent. grade, narrowing toward the lower end. The undercurrent

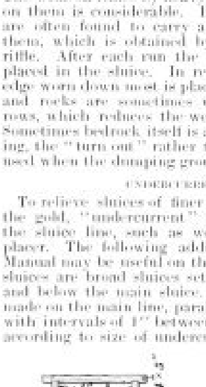


Fig. 17.—Flume Construction.

proper is a shallow wooden box, 20 to 50 feet wide and 40 to 50 long, with sides 16'' high, ten times the width of the main sluice. The bottom is of eleven and half inch plank, tongued and grooved, set on a grade 8 to 10 per cent., according to the smoothness of the riffles employed. It is paved with cobbles, wooden rails shod with strap iron, or small wooden blocks. With the smooth rails a grade of 12'' in 12 feet is enough, but with blocks 14'' in 12 feet. Gravel escaping from undercurrent is led back to the main sluice.

TAILINGS AND DUMP.

Tailings are the refuse from quartz drift, hydraulic mines and stamp mills; debris is another term for the refuse of hydraulic mines. The accumulation of these and the amount thrown into rivers is sometimes prodigious. It is estimated that between 1880 and 1881, in one year, there were discharged into the streams and valleys of California, between Chico creek on the north and Merced river south, 47,000,000 cubic yards of debris from gravel mines and stamp mills. The tailings from stamp mills consist of finely comminuted quartz and in some cases pyrites carrying some fine gold. That from placer and gravel washing is of all forms, kinds and dimensions. Light particles of soil, loam, sand, are easily carried forward by running water, while rocks and boulders escaping from sluices soon find bottom and lodgment. By far the greater part of the material washed remains comparatively near the ends of the sluices in the canyons until removed by heavy freshets. Farmers therefore have less cause to complain of placer workings than of stamp mills on these rivers. It is the finest and lightest material, such as the tailings from stamp mills, that is held in suspension until the velocity of the water carrying it is greatly reduced.

The depositing of this material on lands overflowed during high water was one of the original causes of the disputes between placer miners and farmers that, brought before the law courts, has stopped placer mining in California for so many past years.

DUMP.

This is a very important consideration in hydraulic mining. Where thousands of cubic yards of gravel are being washed daily from their position, places must be provided at lower elevations where the gravel can be deposited. A larger superficial area is required than that occupied by the material before removal. The want of dump room is remedied in some cases by discharging into a mountain torrent as in the first pit at Roscoe, and where placers are on the borders of large rapid streams. To show the evil, however, of dumping into streams, Bowie cites the case of the Light claim, which was worked in 1873, and up to June 23, 1874, had discharged 720,086 cubic yards of gravel into the stream; 975,064 cubic yards were at the same time dumped from the Kelly and French hill properties. At the end of twenty-one months the channel opposite the Light claim was filled up, sluices run out of grade, river bed shoaled on all sides, and the water of a formerly rapid stream struggled over the accumulated debris with a barely perceptible motion and the claim had to be closed.

Where a small amount of tailings is discharged into narrow and steep canyons as, for instance, Clear Creek canyon, Colorado, winter rains and spring freshets suffice to clear it out, but where the quantity is large, in spite of the water, the ravines fill up gradually and hydraulic mining in these localities ultimately ceases. Sometimes, the want of dump room is obviated by a tunnel, by means of which tailings are conveyed into large and precipitous ravines, where they are easily removed.

Iron and Steel Roofing and Siding.

We have received from the Garry Iron and Steel Roofing Co., of Cleveland, Ohio, a copy of a handsome catalogue of their products. The corrugated iron and steel roofing manufactured by this company is recognized in many mining regions as the most durable and convenient for mine buildings and we heartily recommend the Garry roofing and siding to our readers.

"P & B." Paint.

It seems almost useless to mention the old reliable "P. & B." paint to mine owners and mine managers as a most efficient means of economizing at the mine.

However, there are many mine owners and mine managers who have never had any experience with it, and some who have probably never heard of it. We therefore briefly call attention to it, as we consider it the province of such a journal as this to keep its readers informed on all first-class appliances or means, for securing greater economies in mining.

"P & B." paint has for its base a mineral pronounced by chemists to be practically indestructible. When dry on exposed surfaces it is more fire-proof than many of the so-called fire-proof paints. Neither salt nor fresh water, alkaline or acid solutions of any kind make any impression on surfaces coated with it. It preserves iron and other metals from rust, and when applied to clean surfaces completely arrests oxidization. One of its chief ingredients is the most volatile liquid known to chemistry. This liquid evaporates immediately after the application of the paint and causes the mineral to penetrate deeper into the pores of the metal than any other coating. In consequence, the expansion and contraction and the ordinary cracking and breaking of other coatings do not occur with this paint. For this reason it is especially well adapted for metal, etc., which is called upon to stand fluctuations in temperature. It absolutely fills the outer pores of any substance, and being in its nature very elastic, makes an absolutely preservative coat. This paint sets quickly and as soon as dry is tasteless and odorless. It is put up in liquid form of the proper consistency for application with a brush. In color it is a good black, leaving a coating similar to Japan.

It has been in use since 1885 and experience has demonstrated it to be an invaluable article for use around mines. As a protection to iron or metals of any kind in resisting the corrosive elements in mine water it has stood all kinds of tests in a satisfactory manner; on working barrels and chambers of pumps, on both the inside and outside of column pipe, on discs of fans, on screen segments, etc., it has been used to very great advantage. The latter will last much longer if coated with "P. & B." paint than they will otherwise. It is an excellent coating for telephone wires, bell wires and steam pipe covering where they are carried in the mines as well as above ground. Steam pipe covering, whether of asbestos, cement or almost any other non-conductive material, will absorb moisture if not coated with such a paint, and the pipes will corrode under the covering.

Its use on such parts of mine pumps and column pipe as are exposed to the action of acidulated mine water will result in very materially lengthening their life at a very insignificant cost.

This paint is manufactured by the Standard Paint Co., of No. 2 Liberty street, New York, and is guaranteed by them to meet all claims made for it. In view of the long and successful use of this paint by many mine managers such a guarantee seems unnecessary, but it is made for the benefit of those who have never tried this excellent article.

THE DAYTON, TENN., DISASTER.

Full Particulars and Descriptions of the Mine Previous and Subsequent to the Explosion.

Written for The Colliery Engineer and Metal Miner by W. M. Gibson, E. M., Supt.

The Nelson mine, the scene of the terrible disaster on the morning of the 20th of December last, whereby twenty-eight men and boys lost their lives, is owned and operated by the Dayton Coal and Iron Co., Ltd., and is located on the eastern side of Walden's Ridge, about 1½ miles northwest of the town of Dayton. The seam belongs to the lower coal measures, is of a dry and gaseous nature, and has an average thickness of five feet, with a slight general dip to the northwest. The overlying strata, or covering of sandstones and shales, varies in this locality from 350 feet to 1,200 feet in thickness. At some time in the remote ages the main body of the mountain, which is here twelve to fourteen miles wide, has evidently subsided, throwing the measures on the eastern side into a series of ridges or terraces, and bequeathing to future operators every roll and twist known to the geologist and mining engineer, and every degree of inclination from the horizontal to the vertical. These ridges or terraces run nearly parallel with the mountain and vary in height from 5 feet to 125 feet.

Operations were first commenced in the fall of 1886, and have continued almost without interruption since, the developed territory up to present date amounting to nearly four hundred acres.

For some time previous to the disaster, the daily output was about 350 tons, and the number of employes inside the mine amounted to 130. The system of working may be described as that of the single entry, pillar and stall, but, under the peculiar conditions, method is out of the question, and modifications to suit the different circumstances are frequent.

There are three entrances, known as the "Main," Entry E" and Dixon Slope,"

The first named has an altitude of 982 feet above sea level, and 280 feet above the valley in which the town of Dayton stands, and it is the principal artery of the mine. Through it all the coal is delivered to the tipple, which is located close to the entrance.

Entry E entrance is situated 1,500 feet, and Dixon Slope entrance 4,300 feet northeast of the main entrance, their altitudes above sea level being 924 feet and 891 feet respectively. These two entrances are merely used at present for ventilating, traveling and pumping purposes.

The mine is divided into districts, numbered from 1 to 10 inclusively, but of these only Nos. 1, 2, 7, 9 and 10 have been at work for the past few years. The coal is brought from the working places by mules to the main side track in each of these districts, and from there taken to the outside by rope haulage. The longest pull is from No. 10 side-track, a distance of 3,500 feet, the difference in levels being 376 feet. This gradient is not regular by any means, but varies from nil to 35°. On a branch haulway known as Entry O, there is for a distance of 350 feet, a gradient varying from 26° to 37°.

The ventilation was secured by a 7 ft. Sturtevant steam fan, placed near the main entrance, giving 35,000 cubic feet per minute, with a W. G. of .8 and 190 revolutions.

The current for Nos. 1 and 2 districts enters at the main entrance, that for 7 and 9 districts at Entry E entrance, and that for No. 10 district at the Dixon Slope entrance.

Two shifts were employed in the mine—the first entering at 6:30 a. m. and the other at 6 p. m., the latter shift, however, only comprising a few men and confined to No. 10 district.

For the past seven years careful inspections have been made, by competent fire bosses, of all working places, and roadways leading thereto before each shift entered, also at noon each day after shot firing—this latter precaution being necessary to avoid fires. Miners were allowed to fire their own shots twice each shift, but were limited to a certain hour each time, except in special cases.

Naked lights were used exclusively, with the exception of one short section of Entry D, in No. 9 district, that adjoined some old workings that were difficult to ventilate on account of the top having closed in. One end of this section was guarded by a trapper, and the other by a deputy fire boss named Tom Hawkins, whose duty it was to attend to a trap door at his station and to carefully watch for any symptoms of fire-damp, and, in conjunction with the trapper, see that only safety lamps were used by those who had occasion to pass that way. This fire-damp was about forty feet from the entry, and only showed its presence in the test lamp once in a while, but there were no means of knowing its volume, hence the above precautions.

The morning of the disaster was wet and stormy, but the fire boss and his assistant on their tour of inspection found nothing unusual inside the mine to arouse their suspicions of any lurking danger. The air currents were traveling in their usual volumes and customary courses, and the roadways and working places (excepting rooms Nos. 1, 2 and 16, off Entry K, see plan) were safe and free from fire-damp. In each of these he found a very small quantity of fire-damp, so small, in fact, that he hesitated a little about marking them as dangerous. However, he did so in the customary manner, and after completing his rounds notified the miners at the stations as to the condition of their working places, and returned to the outside to make his report in the book kept for that purpose. While doing so, information came to the mine boss that an explosion had occurred in or near No. 10 district, and this was soon confirmed by the rush of excited employes from the other districts to the outside. This was about 7:30 a. m.

A search party was immediately organized and sent in to investigate, but they were unable to get beyond No. 9 side-track on the main entry on account of the after-damp. Meanwhile some men from No. 9 district reached the outside, with one of their number scorched and bruised considerably.

On the writer's arrival two other parties were organized—one to enter at the Main entrance and the other at the Dixon Slope entrance. This second party did not succeed in getting beyond No. 10 side-track, on the main entry, but a third party, which was organized in the interval, by following the intake current of No. 7 and No. 9 districts, succeeded after several unsuccessful attempts in reaching the body of Tom Hawkins (No. 7 on plan) about 2:30 p. m., which they found thirty feet or so south of his station, on Entry D.

This was the first body recovered on this side of the mine. There were no signs of burns on his person or clothes, but a large gash on the left side of his head showed that he had been knocked down by the force of the explosion, and in this way made an easy victim to the after-damp. Several miners passed him while he was still conscious, but he made no request for help, and they, believing he would follow them, went on. An empty car stood in the doorway at his station, and the mule lay dead immediately in front of it.

The Dixon Slope party succeeded in reaching the bodies of the men numbered 1, 2, 3, 4, 5 and 6, on plan, in the rooms to the east of Entry K, about 9:30 a. m., and soon afterwards had them removed to the outside. These men had evidently endeavored to reach Entry K, but being in the dark and doubtless excited, they became confused and wandered aimlessly around until overcome by the afterdamp. Small (No. 1), as will be seen from the plan, almost succeeded in reaching the desired point.

Heavy falls prevented further progress being made on that side that day, and all attempts on the other side were rendered futile by the after-damp, until about 3:00 p. m., when the body of Washburn was reached, No. 8 on plan. Nos. 9, 10, 11, 12, 14 and 15 were also reached a few hours later, and by early morning No. 13 was found. Thus, in less than twenty-four hours' time, fifteen bodies had been recovered and removed to the outside.

Nos. 8, 9, 10, 11 and 12 were drivers, and their mules were found close to their bodies. This is the principal gathering point or side track for this district, and appearances would indicate that these drivers were on the eve of starting out on their day's routine.

Several very heavy falls were encountered on Entries L and K between Entry G and the entrance of No. 3 room, and a considerable quantity of the debris had to be removed before some of the bodies could be recovered, also before further advance could be made. All these bodies were more or less burned and bruised.

Early next morning a search party succeeded in crossing the fall, and immediately at the entrance of No. 2 room found the body of Henry Williams, (No. 16 on plan), face downwards and lying diagonally across the entry, his face and head considerably bruised. Continuing their explorations, they soon afterwards found those of T. Lane and son (Nos. 17 and 18 on plan) lying side by side. In the former's pocket was a watch, the hands of which pointed to 7:22½, evidently the time at which the explosion occurred. A little later the body of trapper Morgan (No. 19 on plan) was found near his station or door. An attempt was then made to explore No. 7 room, but fire-damp was encountered 300 feet above its junction with Entry K, rendering further advance impossible. They then returned and had the bodies removed to the outside.

Later in the evening two other parties entered—one at the main entrance and the other at Dixon Slope entrance, and met on Entry K, and thus for the first time since the disaster established communication between these two entrances.

A little later the Dixon Slope party discovered and removed the bodies (Nos. 20, 21 and 22 on plan). All that night a crew worked on the falls on Entry L, and next day, Sunday, the bodies of three mules were removed and the other two on the day following.

All energies were now directed to the removal of the large accumulation of fire-damp on the west side of Entry K, amounting to nearly 400,000 cubic feet, and for this purpose three shifts of men, varying from five to seven in number, each in charge of a competent foreman and equipped for restoring brattices and doors and cleaning up debris, were detailed for duty each day. This gas was exceedingly strong, and evidently contained a considerable quantity of carbonic acid gas. Consequently progress was slow, but finally, on the morning of the 27th, Nos. 7 and 8 rooms were cleared and the explorers were able to advance. The bodies (Nos. 23, 24, 25 and 26 on plan) were found in an advanced stage of decomposition. Each was lying face downward, head toward Entry K, and their faces showed signs of having been subjected to intense heat. The first was partially raised on his elbows, as if in the act of making a final effort for life. The body of the mule driven by him was found at the face of No. 8 room, lying in front of the rear end of the empty car, the tail chain stretched across it and fastened to the front end, showing that the driver had reached there just as the explosion occurred. The cap of one of the other victims was found close to the face of the room, also some clothes and dinner buckets at their "box" or resting place, a short distance back from the face.

Entry P was then attacked, and after a bitter fight the bodies of the last two remaining victims (Nos. 27 and 28 on plan) were found and removed on the night of Jan. 4th, sixteen days after the disaster. At this point there was an overcast, and as the bodies of these two victims were found on top of the fallen timbers, it is evident they had passed this point and been blown back by the force of the explosion. Both were lying prostrate on their backs and at right angles to each other. The head of No. 28 was crushed flat by a large rock weighing 150 to 200 pounds, which had fallen from the roof. The odor from the bodies of these last two victims was no worse than that from the four found the week previous. This was rather surprising to the rescue party, who anticipated something worse and were fully equipped with sponges, camphor and carbolic acid. Probably the fire-damp had some preservative action.

In addition to the falls already referred to, there were several very heavy ones on Entry K, between Nos. 7 and 13 rooms, also in Nos. 9, 10 and 11 rooms. These rendered the work of the rescue parties extremely perilous, and it was only by the exercise of the greatest possible care that accidents were avoided. Slight falls were frequently met with in other sections of the district.

The explosion evidently originated in No. 2 room and radiated in all directions therefrom. The fallen props, blown out brattices, doors and gobs, and collections of dust on the standing props, and loaded cars in this and adjoining rooms, all point to this conclusion. The coal on the rib sides in this room was slightly charred, and several of the props had a thick caking of charred dust on the side next to the "face." This charred dust was also found adhering to the props in Entry P_2 air-course near to its junction with No. 7 room, in No. 1 room near face, in No. 7 room about 200 feet back from face and at various other points throughout the district.

The "blast" evidently traveled on the north side against the air current, along Entry K, No. 7 room and Entries P_1 and P_2, and on the south side with the air current, along Entry L, and the haulway to No. 10 side-track and up the branch haulway to Entry D.

A young man, named Oscar Hawkins, who was passing this point on Entry D, just at the time with his mule and car, was blown out of the latter by the force of the blast, and considerably bruised, also severely scorched about the face and neck.

Another young man who was in front of him some distance and going in the same direction, was also blown from the car in which he was seated, over and beyond the mule, but escaped with merely a few scratches.

Both describe the blast as a terrific gust of hot air, filled with dust, resembling a thick, black rolling cloud. The destruction of the brattices was very complete, especially in Entry P_2, where it was difficult to find a piece of plank larger than 6″ x12″. This, of course, can be easily accounted for by its being a "butt end" and the space very limited.

There are indications of there having been but little flame at any point in the entire district. Pieces of paper and brattice cloth were found unscorched even within a very short distance of the point of origin, also kegs of powder; and all the physicians in their depositions stated they were inclined to believe that the burns on the victims were the result of intense heat only. This belief is strengthened by the fact that few of their clothes were even scorched.

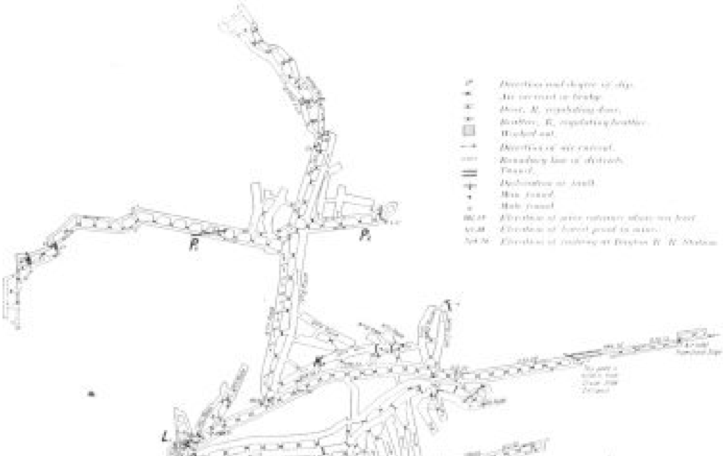
Several theories have been advanced as to the cause of the explosion, but the only feasible one to the writer's mind is that it was the result of some one crossing the danger mark, in No. 2 room, with a naked light, and setting fire to the small accumulation of fire-damp there, which communicated with the dust, causing the fearful carnage referred to. This opinion is shared by all the officials of the mine, also by State Mine Inspector Clute, who was on the ground during the rescue work and made a thorough investigation into the cause and origin of the disaster.

An ordinary miner's lamp, with Williams' name cut on the lid, was found in this room, about fifteen feet from his body, and this, together with the position of his body, makes us believe he was the transgressor. This room was Bennett's and Williams' regular working place. Two other men had worked in it with naked lights within twenty feet or so of the face, on the previous shift, until 3 A. M.

On the morning of the disaster, 113 men and boys and 20 mules entered the mine, to be distributed as follows:

District.	Men.	Mules.
No. 1	22	5
No. 2	14	1
No. 7	13	2
No. 9	20	5
No. 10	28	6
Miscellaneous	16	

These last named belonged to no particular district.



Plan of Districts Nos. 9 and 10, Nelson Mines, Dayton, Tenn. Scale, 1 in. = 400 ft.

One of the number bound for No. 10 district was detained on the way, and thus escaped the fate of his comrades.

Six of the mules were rescued on the day of the explosion, and one four days later. This one was overlooked in some way, and given up as being dead. When found, it was gnawing at some cross ties in No. 1 district, and in a very weak condition. How it escaped, is a mystery.

There have been two or three slight explosions of fire-damp in different working places in this section in the past, burning the occupants to some extent, but never extending beyond a very small area each time. In fact, the district was considered one of the safest in the mine. It is very gratifying to be able to state that none of the rescuers received the slightest injury during their perilous work.

On the 23rd of September, 1889, an explosion of fire-damp occurred on the main entry, between Nos. 7 and 8 side-tracks, burning nine men severely, three of whom died shortly afterwards. This was caused by carelessness on the part of the inside foreman, who, in making his rounds, neglected to extinguish the naked light on his head. He was seriously burned himself and died a few days afterwards.

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

The Fifth Root.

Editor Colliery Engineer and Metal Miner:

SIR:—If I am not intruding too much on upon your time, I wish to ask if Ajax is not giving us a rule that will not work as well as Dr. Halley's, *i. e.*, the rule which I sent for your February number. I have tried ten or twelve questions by Ajax's rule and could not get over two right. I wish to give Ajax two questions to work, and if he gets them as correct by his rule as by the rule which I gave, I will admit its correctness, as it is much easier to work than mine. Will Ajax kindly work the "fifth" root of 9 and "fifth" root of 21035.8? By my rule I get for $\sqrt[5]{21035.8} = 7.321590$, and the fifth power of 7.321590 = 21035.789. Now, I took 7.2 and 7.4 as trial roots, and I find it wrong. I have tried $\sqrt[5]{9}$ with the same result, and fear that Ajax has not proved his rule, and he will oblige me if he will work them out for your next issue. Yours truly,

THOS. HANNAH, Dunlo, Pa.

The Fifth Root by Arithmetic.

We are in receipt of a method of finding the 5th root of any number by means of arithmetic, submitted by Mr. J. Bucher, of Dysart, Pa., but do not publish it, as his solution is the same as that submitted by Mr. Robert Hinning, of Carterville, Ill., which appeared in our September, 1895, issue.

Broken Shaft.

Editor Colliery Engineer and Metal Miner:

SIR:—I would be obliged if you would insert the following in reply to Mr. Noll's inquiry in the March issue:

QUES.—At Kangley Mine No. 2 we are using an endless rope system of haulage with 2¼ miles of ⅞" crucible steel wire rope worked with an engine of the Litchfield pattern with 12"x20" cylinders and a 7 foot cog-wheel to which is attached a 4 foot drum. Placed 3 feet behind this drum is another drum which is equipped with Walker's slide rings. This drum is not connected with the engine, but is worked by the rope passing from the forward drum back over the Walker drum with five laps, thence to the tension wheel, and on to the inside. The shaft, which is a six-inch one, has broken at two different times within four months. What would cause the breakage of such a large shaft, it being only 4 feet long? Could the variations in the grooves of the drum made by the wear of the rope cause the fracture?

If the drums were not set true with each other, would that cause the break?

ANS.—The Walker drum is used as the idler, and in this case only does away with half the crave on the drums. It would be better if there was another Walker drum connected with the engine, as that would reduce more of the craving.

If the drums were loose on the shaft and made tight enough by friction, instead of by a key, to pull the working load, then, in case the cars should be derailed, the drums would stop and leave the engine in motion; then no sudden strains could be thrown on shafts, which accounts for broken shaft. Yours truly,

SAMUEL G. MORGAN,

Nanticoke, Pa., April 9, 1896.

Answer to Geometrical Problem.

Editor Colliery Engineer and Metal Miner:

SIR:—Please publish the following solution in answer to question asked by J. S. P., of Reynoldsville, Pa., in the April issue of your valuable journal. "A tree 120 feet high stands on the bank of a river 100 feet in width. At what distance from the ground should the tree be cut so that, in falling, the top will just reach the opposite bank of the river?"

In analytical trigonometry we have the following rule: Half the perimeter of a triangle is to its excess above the base, as the cotangent of half either of the angles at the base is to the tangent of half the other angle. As one of the angles at the base is a right angle, we have $\frac{90}{2} = 45°$ and cot. 45° = 1. $\frac{100 + 120}{2} = 110$ feet. 110 − 100 = 10 feet = excess of perimeter above the base.

110 : 10 :: 1 : .09, .09 = tan. 5° 11' 40" nearly, and 5° 11' 40" × 2 = 10° 23' 20" = angle of fallen tree with the base.

Therefore, tangent 10° 23' 20" = .18334. .18334 × 100 = 18.334 feet. Ans.

Proof: $\sqrt{18.334^2 + 100^2} = 101.666$ feet and 101.666 + 18.334 = 120 feet. Yours etc.,

J. G. WILLIAMSON.

Scammon, Kans., April 14, 1896.

Let x = fallen tree from point cut to top, y = part of tree standing, and z or 100' = stream.

Then $x + y = 120'$.

$x^2 + 2xy + y^2 = 14,400$.

$x^2 - y^2 = 10,000$ (the difference of the squares of hyp. and perp. = square of base.

$2x^2 + 2xy = 24,400$.

$2x^2 + 2xy = 240x$. (Multiplying the first equation by $2x$.)

$240x = 24,400$. (Axiom—Things equal to the same thing are equal to each other.)

$x = 101.66\frac{2}{3}$.

$y = 120 - 101.66\frac{2}{3}$ or $18.33\frac{1}{3}$. The point above ground that tree must be cut. Yours,

WM. MACTAGGART.

Jeanesville, Pa.

I beg to submit the following rule: Square the height of the tree; from the product, subtract the square of the base; divide the remainder by twice the height of the tree. The quotient will be the leg of the triangle or the height, from the ground, at which the tree must be cut in order to just reach the opposite bank of the river. Also total length of tree minus the height at which the tree was cut is equal to the hypothenuse of the triangle.

Solution: $[(120)^2 - (100)^2] \div 2 \times 120 = 18\frac{1}{3}$ feet, or height at which the tree must be cut.

WM. DUNCAN.

Dunbar, Pa., April 16, 1896.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—In going over my copies of THE COLLIERY ENGINEER AND METAL MINER, on page 129 of the January, 1895 issue, I notice the following question and answer, the latter given by one of your staff of writers:

"If you had 150,000 cu. ft. of air passing per minute through an airway 8'x10' what would be the H. P. of the ventilation apart from friction?"

ANS.—"In this case the H. P. would only be required to set the inert air in motion at the mouth of the shaft. Then let v = velocity in feet per second and $\frac{150,000}{80 \times 60} = 31.25$ and let .077 be the weight of a cubic foot of air, then $\frac{v^2 W}{64.3} = F$, or F is the foot-pounds of work per square foot of area; and as there are 80 square feet in area of section, it follows that $\frac{31.25^2 \times .077 \times 80}{64.3 \times 550} = .01701$ or the required H. P. is .01701."

Now it is manifest that there is something radically wrong in the above if the following reasoning is correct:

150,000 cu. ft. of air passing through an airway 8'x10' would have a velocity of $\frac{150,000}{(10' \times 8') \times 60} = 31.25$ per second. The head due to such velocity expressed in inches of water gauge is (assuming air to be .0766 lbs. per cubic foot),

$$W.G. = \frac{\frac{31.25^2}{64.4 \times 5.2}}{.0766} = .223.$$

The H. P. of ventilation then apart from friction must surely be $= \frac{q \times W.G. \times 5.2}{33,000} = \frac{150,000 \times .223 \times 5.2}{33,000} = 5.27$ H. P. Ans. Authority, "The Colliery Managers Handbook."

Let us take another arrangement of the same result: $\frac{150,000}{(10' \times 8')60} = 31.25$; $\frac{v^2}{2g} = \frac{31.25^2}{32.2 \times 2} = 15.16$.

The weight of a cubic foot of air at 62° under ordinary pressure = .0763122 lbs., consequently, 15.16 × .0763122 lbs. = 1.1569 lbs., the force engendering the motion of the air. Since $\frac{q \times p}{33,000}$ = H. P. then $\frac{150,000 \times 1.1569 \text{ lbs.}}{33,000}$ = 5.27 H. P. Ans. Authority, Wm. Fairley on "Ventilation."

Let us take another. In the example given the quantity passing per second $= \frac{150,000}{60} = 2,500$ and the velocity is consequently $\frac{2,500}{10 \times 8} = 31.2$. If friction be absent, $v^2 = 2gh$. In this case h, or head, $= \frac{31.2^2}{64.4} = 15.2$. To completely solve the problem the temperature and pressure must be assumed. At the normal temperature, pressure of 13' of air column weighs 1 pound and therefore, in this case, the pressure per square foot producing the velocity is $\frac{15.2}{13} = 1.16$ lbs.

The H. P. required is the quantity per second × pressure ÷ 550, or $\frac{2,500 \times 1.16}{550} = 5.27$. Ans. Authority, "A Text-Book of Coal Mining."

The question may be solved by finding the theoretical water gauge necessary to produce a velocity of 31.25 feet per second.

$$W.G. \text{ (in inches)} = \frac{\frac{1.3253 \times H}{459 + t} \times \frac{v^2}{2g}}{5.196},$$

v = velocity in feet per second, g = gravity, h = height from which a body must fall in order to generate v, and H = height of barometer.

In this case the above formula will give W. G. = .23 lbs., consequently

$$\frac{2,500 \text{ cu. ft. per second} \times .23 \text{ lbs.} \times 5.2}{550} = 5.26 \text{ H. P.}$$

If the value of coefficient of friction could be accurately determined, then, strictly speaking, this value or H. P., or whatever it may be, should be added to the value for frictional resistance. For example: If in the preceding example it was found that 50 H. P. was developed in overcoming frictional resistance and the H. P. due to the quantity is 5.27 H. P., then the true answer would be 55.27 H. P.

When it is noted how very small is the pressure required to produce velocity, and also the fact that the resistances are only estimated approximately, it is not surprising that the pressure to produce the velocity is neglected. The calculations are made easier by each neglect.

I have not been very particular in extending my figures or in using precisely the same values in the different cases to get the answers, my object being merely to show the principle. Yours truly,

W. D. L. HARDIE.

Birmingham, Ala., April 11, 1896.

[NOTE BY THE EDITOR:—On examination of the question and answer we find that Mr. Hardie is correct, and that the error in our answer was due to two errors. One in placing the decimal point incorrectly, and making 0.1701 read .01701, and the other in failing to multiply the 0.1701 × 31.25, which would have given a result of 5.3156. This practically agrees with Mr. Hardie's answer.]

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue or three months subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for May.

QUES. 223.—In trying to find out the combustible substance that would give the best results in generating the flame in our new safety lamp, I have fallen across the following facts that completely puzzle me, and as I am afraid that any further attempts to solve the riddle would drive me to distraction, I will be obliged to you if you will show to me how it occurs that when two volumes of pure hydrogen combine with one volume of oxygen, more heat is given off than when one volume of marsh gas combines with two volumes of oxygen. One thing I have noticed that may help you to find an answer, and that is, the hydrogen and oxygen produce water that is a liquid, whereas the marsh gas and oxygen produce liquid water and a permanent gas, and, strange to say, coal gas that contains a high percentage of C_2H_4 gives off less heat than CH_4, and oils, such as are burned in lamps, give off less heat per unit of weight than any of the gases under notice, and yet we know that a large percentage of energy is concealed somehow in burning these hydro-carbons, but it is not given off as heat, but I have no doubt you can tell me something that will remove the mystery.

QUES. 224.—All the plants in the vegetable kingdom of life are grouped under four distinct divisions, as Thallogens, Acrogens, Endogens, and Exogens. Will you, therefore, name for me a single example in each division that flourished during the Carboniferous period, and also a single example in each division of plants that are living now in your state or country?

QUES. 225.—A mine shaft is 3,000 feet deep, and I wish to know what weight a first-class steel rope, 1½ inches in diameter, will safely carry in hoisting coals up this shaft.

QUES. 226.—Will you explain to me, with a neat drawing, how it occurs that the horizontal planes at the two ends of a perfectly straight line of sight are never parallel, although the telescope is set truly level at the ends in question? Again, while you are busy, you might show me how it is that we cannot get a "perfectly straight" line of sight, and the longer that line is, the greater is the divergence. Further, make a bold finish by showing the reason why a sight made over a surface heated with the rays of the sun can never be trusted for accuracy.

QUES. 227.—To work a valuable coal seam, we must deliver onto the nearest railway with a branch road of our own, and as the surface is very uneven, and the possible duration of the seam does not warrant the making of cuttings and embankments, we will deem it a favor if you will advise us about the haulage we should make to be cheap in construction and efficient in action, and, if possible, please support your conclusions by reference to actual cases, and be careful to note that we have decided against every kind of locomotive traction.

QUES. 228.—Sometimes in mining, where the seam is situated above the drainage level of the district, water can be collected at the surface and conveyed down the shaft in pipes to do the work required in pumping, hauling and ventilating. This great water power is applied through the medium of hydraulic engines, in which a stream of high pressed water is projected onto reaction blades, whose surfaces are curved to secure total reflection instead of simple deflection. Now, to make sure that we all understand the explanation given, will you still further assist us by answering two questions?

First—What are the curves that are given to the inside surfaces of the reflecting cups, of the reflex water wheel.

Second—Show by a sketch and the necessary explanation, that with total reflection more power is obtained than could be secured with a deflection of 90° from the plane of the wheel's rotation.

Answers to Questions which Appeared in the March Issue and for which Prizes Have Been Awarded.

QUES. 211.—As we are striving to make our proposed new safety lamp the best in the world, it certainly should be of some service in testing for gas, and as we require some additional information to enable us to make it so, let us band ourselves together for mutual help and we are sure to succeed. Then let us know at once what makes the gas cap tail up in a blue stream above the ordinary flame of the safety lamp?

ANS.—The blue cap is a blue lambent flame characteristic of carbon monoxide burning into carbon dioxide. Its presence on the flame of the safety lamp is due to imperfect combustion, for as little as 3 per cent. of marsh gas in air produces this effect. The marsh gas on contacting with the bottom of the flame burns off so much oxygen that the remainder in the air is not sufficient to fully burn the carbon of the oil into carbon dioxide, and, therefore, when the carbon monoxide reaches the higher stratum where more oxygen is available it burns into the dioxide and in so doing produces the characteristic blue cap.

D. J. LEWIS,
Elliott, Randolph Co., Mo.

QUES. 212.—When an explosion of fire-damp occurs in a coal mine, immense volumes of gas and air rush up and out of the shafts, and at the same time the expanded air and gas rushes into and becomes compressed in the gobs, do you think then that a correct sample of the after-damp produced by the explosion is procurable, and if so, where would expect to find it? And while so doing, will you explain the recoil, or back rush of air into the levels, rooms, etc., after the blast has expended itself?

ANS.—A correct sample of the after-damp cannot be obtained because a considerable proportion of the products of combustion has been ejected from the mine by expansion, as proved by the outrush, and what remains has been diluted by the back rush, therefore the best approximate sample could only be found in such rooms as would be subject to a back rush of nearly pure after-damp. The back rush is caused by the partial vacuum resulting from the cooling of the after-damp.

JAMES TASKER,
Old Forge, Pa.

Second Prize, JOHN FLETCHER,
428 Tonti street, La Salle, Ill.

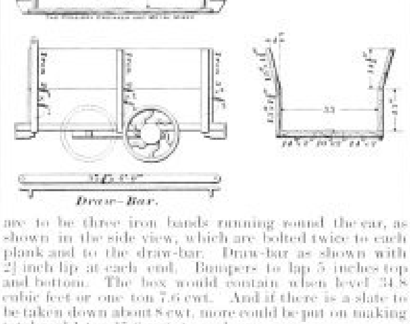
QUES. 213.—I am a mine superintendent for the Black Band Coal and Iron Co., and the principal director has requested me to read a paper before a meeting of the mine foremen of the district on the principle of construction and the mode of action of the electric motor, such as is used for mine haulage. He says the description must be brief and applied entirely to the magnetic field, and must only mention the commutator by a reference to its use. Now, as electrical appliances have come to the front for mining, I must either write this paper or lose my position, and I do think you will therefore make an effort to help me. Then, please give me the principal points required for a good paper.

ANS.—To illustrate the subject more clearly take the T. M. M—25, 100 H. P. locomotive now manufactured by the General Electric Co., and follow the current from the trolley wheel to its return to the rails. The current runs down an insulated wire connected with the brass wheel on the trolley arm, the other end connecting with the controller (the current being a direct one), which connects the current with the two motors on the driving wheels. The controller has a reversible lever which allows the locomotive to run in either direction. The principal features here are the five notches used in starting, each notch, like the notches of the lever bar in a locomotive, only allows so much current to pass to the motors, the remainder going to the rheostats, of which there are four. One notch throws into the circuit the four, two notches throw out one, three notches throw out two, four notches throw out the third, and the fifth notch throws them all out. The rheostats are built up of sheet iron ribbon packed in asbestos and mounted in fire brick, so as to be absolutely fire-proof. This is to take up in resistance the surplus current, not allowing the whole current to be exerted on the motors. When the controller is thrown wide open, the current passes direct to the motors, part of the current goes to the field or magnetic poles, to excite the field magnets and the remainder goes to the commutator to be changed to positive and negative electricity, the current then passing round each section of the armature as they come under the brushes. The armature is composed of a number of flat coils of copper wire placed on their edge against the core, and insulated from each other; one end of each of these coils is connected with a segment of the commutator, and the other end is fastened to the next segment, and so on round the commutator, and then each segment of the commutator is connected to the one on the opposite side by short insulated wires. The direct current can be changed to an alternate one by passing through a commutator or *vice versa*. The current flows in through the brush to a section of the commutator. Thence round a coil of the armature, back to the next section of the commutator and is returned through the other brush to the wheels, and thence to the rails, which are again connected with the generator, thus completing a ground circuit. When the field magnets are excited and a current flows through a coil of the armature, the magnet attracts this coil till it is directly under the magnet; then the next one is attracted, thus causing revolution of the armature, which is geared by pinions to the driving wheels. The motor used is the bipolar water proof, with only one spool-piece.

H. K. MOBERLY, West Newton, Pa.

QUES. 214.—We are about to open out a fine seam of bituminous coal that is 5 feet thick; and to work it we are going to sink shafts that will be 820 feet deep. Before, however, fixing on what should be the sizes of the shaft sections, we wish to determine what have to be the dimensions of the cars. The specific gravity of the coal is 1.27, and we want an output of 1,000 tons per day; will you then, give us a sketch in elevation of the car you would recommend, and be careful to give the dimensions and capacity of the box, the sizes of the details of the bottom frame, and the sizes of the wheels and axles.

ANS.—Would use Phillips Mine Supply patent wheels 18'' diameter and 2'' axles placed 22 inches apart. There



Draw-Bar.

are to be three iron bands running round the car, as shown in the side view, which are bolted twice to each plank and to the draw-bar. Draw-bar as shown with 2½ inch lip at each end. Bumpers to lap 5 inches top and bottom. The box would contain when level 34.8 cubic feet or one ton 7.6 cwt. And if there is a slate to be taken down about 8 cwt. more could be put on making total coal 1 ton 15.6 cwt. to each car.

H. K. MOBERLY, West Newton, Pa.

QUES. 215.—In surveying around the bottom of a mountain, we made all the necessary levels and insets to determine the correct figure of a truly horizontal base that was just touched by the western side of an outcropping coal seam. From the plat we found the figure to be practically that of an ellipse, with its major axis coursing from south to north 6,012 feet, and the minor axis coursing from east to west for 2,842 feet. The mountain is 1,800 feet high. The coal seam is 4 feet thick, and is overlaid with a strong sandstone. We leveled our transit at a distance of 64 feet eastward of the eastern end of the minor axis, and with the center of the telescope at an elevation of 4 feet 1 inch above the calculated level of the base, the bottom of the coal seam here made an angle of elevation of 38° 26', and the distance, measured in a straight line from the plumb point on the ground to the bottom of the coal seam, was found to be 1,026 feet. Now, I wish to know three things that I am sure you will calculate for me.

First.—What is the pitch of the seam?

Second.—What is the area of the seam?

Third.—What percentage of this seam could be reasonably worked? Show with a sketch how you find the pitch.

[Not one of our many able competitors have supplied us with the correct solution of this question.—ED.]

QUES. 216.—One of the air-ways in a mine is 6 feet high and 9 feet wide, and formerly a large volume of air was passed through it with a ventilating pressure of 1.2 inches of water gauge. Afterward a regulator was fixed in this air-way to reduce the quantity passing to one-third of the former volume, and recently a new ventilating fan has been started at this mine, and it is treble the power of the former one. Now I will be obliged if you will determine for me five things:

First—What is the length of the air-way, taking the co-efficient of resistance at .00000001?

Second—What was the original quantity passing through the air-way?

Third—What is the difference of pressure on the two sides of the regulator now, and what was it before the new fan was started?

Fourth—What is the height of the water gauge now for the drift?

Fifth—What is the quantity now passing through the regulator in cubic feet per minute?

ANS.—Another factor is required for the solution of this question, and that is the velocity, and therefore I assume it to be 1,000 feet per minute, and on this basis the answers to the sub-questions will be as follows:

First—The length of the air-way l.

$$l = \frac{p\,a}{K\,v^2 \times 30} = \frac{1.2 \times 5.2 \times 54}{.00000001 \times 1000^2 \times 30} = 1123.2 \text{ ft.}$$

Second—The original quantity is 54 × 1,000 = 54,000 cubic feet per minute.

Third—Difference of pressure now 11.537 pounds per square foot.

Difference of pressure before, 5.5406 pounds per square foot.

Fourth—The height of the water gauge now with the increased power is $\sqrt[3]{3^2} \times 1.2 = 2.496$ inches.

Fourth—The quantity passing through the regulator now is $\sqrt[3]{3} \times 18,000 = 25,960$ cubic feet per minute.

ADOLPHE COOK, Houtzdale, Pa.

Second Prize—JOHN VERNER, Lucas, Iowa.

The aggregate increase in the population of Europe from 1885 to 1895 was 29,922,800. Russia added 12,510,-800 to her existing population; Germany, 4,522,000; Austro-Hungary, 3,502,200; Great Britain, 2,452,400; Turkey, 1,100,000, and France, 67,100.—*European Economist.*

Semibronze Packing.

This is the name given to a new high grade packing for engines and pumps, manufactured by N. J. Car Spring & Rubber Company, Jersey City, N. J.

The core, which is the foundation of the packing, is a lubricator reservoir, and is composed of loosely spun asbestos thoroughly saturated with high grade cylinder oil, pressed into the desired shape and coated with pure foliated graphite. The covering consists of alternate strands of hemp and asbestos, loosely spun, each braided over with an open work of very fine brass wire.

SEMIBRONZE PACKING.

All of the strands are very loose and fluffy, so that they will readily soak up oil and hold it, and the braiding of the wire being quite open permits the oil to flow readily from the fiber and carry along with it the graphite to the piston rod when heated. Besides serving to hold the soft fluffy materials together, the wire adds to the lasting qualities of the packing, both by its own resistance to wear when properly lubricated and by reason of its protection of the fibers from being blown out of the stuffing box by steam or water pressure.

This packing is used in the same way as common fibrous packings, and needs no special handling or care.

The value of Semibronze packing has been fully proved by actual practice in hard service. It has given entire satisfaction wherever put in, both as to its lasting qualities and the bright appearance of the piston rods.

Most of the piston packings on the market are made without a full knowledge of the requirements. The Semibronze is the result of years of experience of a practical and well-known engineer and pump builder. It is put up in twelve feet lengths, each length in a separate box, labeled, and sells at a popular price. Two brands are made, viz: "Gilt Edge" and "Combination."

Circulars and further information will be furnished our readers upon application to the N. J. Car Spring & Rubber Co.

Compressed Air.

Compressed Air is the title of a neat little monthly publication edited and published by Mr. W. L. Saunders, 26 Cortlandt street, New York. A copy of the first issue is before us, and we take pleasure in testifying to its interest and value. We republish the editor's announcement as a very brief and comprehensive statement of the character of the publication:

"The appearance of this little magazine, published for the purpose of disseminating information regarding this important branch of science, will, we trust, be received with gratification. Thus far the subject has been treated in only a fragmentary way. An occasional book, lecture, essay, or articles in trade papers have been the extent of its promotion.

"Only a small amount of literature on this subject has been separated from trade interests, and the information given has been chiefly of value when examining the relative qualities of the manufacturer's product.

"Compressed air, as a useful power, demands attention. Its scope of usefulness is each day widening, and its possibilities are beyond conjecture. The era of compressed air is even now upon us, and its claims must be placed beside electricity and other great scientific auxiliaries that have been developed in this age of progress.

"We believe that the development of the science of compressed air has suffered for want of publicity. Discussion, controversy, advertising—all lead to a better knowledge of the subject and point the way to larger fields of usefulness. It is this condition which *Compressed Air* seeks to bring about."

The subscription price of *Compressed Air* is $1.00 per year.

An Important Change.

An event of no little interest to mine managers is the recent reorganization of the Dickson Mfg. Co., Scranton, Pa., a company which has a most excellent and wide reputation for its mining and other types of machinery.

The facilities of the company will be greatly enlarged by the addition of much heavy machinery, the erection of larger buildings, and the establishment of new departments. These improvements are being made at once, and the works being put in condition to compete in the open market for all kinds of machinery and locomotives. Large engines for electric light plants, blowing engines and forgings of all sizes will be made specialties. At the same time the manufacturing of first class hoisting, haulage, ventilating and breaker machinery will be given close attention. Prices will be as low as is consistent with first class work, and "up to date" methods will prevail. The new management is composed of men whose names are familiar as successful business men and engineers in all parts of the country.

With the advantages possessed by this company in location, there seems to be no reason why it should not assume greater prominence than ever before, and become an important factor in the manufacture of heavy machinery.

The present organization is as follows: President, C. H. Zehnder, formerly President of the Jackson & Woodin Mfg. Co., Berwick; Secretary and Treasurer, L. F. Bower, formerly General Manager and Treasurer of Carlisle Mfg. Co.; General Manager, De Courcy May, for many years with the I. P. Morris Co., and recently in charge of the work for Cataract Construction Co. at Niagara Falls.

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AND

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All communications should be addressed,

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COMPRESSED AIR AS A MOTIVE POWER.

THE use of some safer, more economical and more convenient motive power than steam, for use in many parts of a mining plant, is a recognized necessity. While electricity meets the want in many instances, there are, undoubtedly, serious objections to its use in some instances. It is not our intention in this article to go into the conditions which enter into a decision as to whether compressed air or electricity should be adopted in any particular instance, but rather to give some few instances of successful installations of compressed air plants and the opinions of mine managers thoroughly conversant with their practical use.

In another portion of this issue we print a detailed account of the compressed air haulage plant at the Susquehanna Coal Company's No. 6 shaft, Glen Lyon, Pa. That this installation has proven successful, is evidenced by the fact that the officials of the company have recently ordered a second compressed air locomotive, and sufficient pipe to largely extend the scope of the haulage by the use of compressed air. Some months ago we published a detailed description of the compressed air pumping plant at the Lehigh and Wilkes-Barre Coal Co.'s Nottingham colliery at Plymouth, Pa. This plant, which is the largest compressed air pumping plant in the world, has given most excellent satisfaction.

The use of compressed air as a motive power for coal mining machines has been eminently successful during the past few years, and has proven both economical and safe.

The compressed air haulage plant at Glen Lyon, while by no means the first, contains some essential improvements in the details of installation that especially commend it. It is the perfection of these details that in a large measure determines the efficiency and economy of a plant.

Compressed air as a power for rock drills in shaft sinking, tunneling, and in ore mining generally has largely superseded steam on account of its great superiority.

The use of compressed air in Cape Breton and Nova Scotia coal mines is ably discussed by three prominent mining officials in a recent issue of our contemporary, *The Canadian Mining Review*.

In discussing the plant at Sydney mines, Cape Breton, Mr. R. H. Brown states that there are two accumulations of water in the workings—one of several million gallons at a distance of 3,580 ft. from the shaft bottom, and at a level of 209.9 ft. below it; the other, a much smaller quantity, at a distance of 1,700 ft. from the first accumulation, and 155 ft. below it. Compressed air is used as a power to actuate the pumps used in draining these distant sumps. The air compressor used is an Ingersoll-Sergeant, Class A, straight line, piston inlet machine. The steam cylinder is 14 in. diameter, air cylinder 14¼ in. diameter, and stroke 18 in. It is erected on the surface 104 ft. from the head of the shaft. It is supplied with steam by one steel tubular boiler, 14 ft. long x 54 in. diameter, having 54 tubes, each 3½ in. diameter. A steel air receiver, 10 ft. long x 30 in. diameter is placed on end outside of the compressor house, and is connected with the compressor by a short pipe 3½ in. diameter.

The water supply for the boiler and compressor is very ingeniously arranged. A small reservoir, 24 feet square, was constructed at a distance of 100 ft. from the compressor, and two lines of 4 in. pipe were laid therefrom to the compressor house. These pipes are underground. One line, 140 ft. long, leads the water direct to the compressor house, where a small duplex Blake pump, having 3 in. steam cylinders, 2 in. water plungers, and 3 in. stroke, elevates into an iron tank placed over the compressor. The bottom of this tank is 9 ft. 10 in. above the center line of the air cylinder of the compressor. The water from this tank supplies feed for the boiler, and cooling water for the jackets of the air cylinder. The other line of pipe, 240 ft. long, takes the cooling water by a circuitous course back to the reservoir. The water is thus kept circulating, and is cooled by its passage through the pipes underground.

The intake air enters the compressor through a short length of pipe 4 in. diameter, projecting through the building into an external box or shaft 12 in. x 22 in. in section and 16 ft. high. The air is thus drawn from a point above the roof of the building, and is free from dust and smoke.

The wrought iron pipe line for the compressed air consists of 2,467 ft. of 6 in. pipe, 1,152 ft. of 5 in. pipe and 860 ft. of 4 in. pipe, from the air receiver on the surface to the air receiver No. 2 in the mine. No. 2 receiver is made of steel plates, and is 8 ft. long by 30 in. diameter, and near it stands pump No. 1. This pump, located 4,479 ft. from the air compressor, is a Northey duplex pump having 7½ in. air (or steam) cylinders, 4½ in. plungers, and 10 in. stroke. It runs at an average speed of 100 strokes per minute, and raises the water to an elevation of 209.9 ft. through 3,580 ft. of 5 in. delivery pipe. It delivers, deducting 5% from the calculated delivery for slip of pump, 64.9 gallons per minute.

From air receiver No. 2 there is a line of 4 inch pipe 1,150 feet farther, down a slope, and thence 400 feet more of 3 inch pipe to air receiver No. 3, which is a counterpart of No. 2. From air receiver No. 3 there is a line of 120 feet of 3 inch pipe to a Worthington duplex pump having 4½ inch air (or steam) cylinders, 2¾ inch plungers and 4 inch stroke. This pump, located 6,149 feet from the source of motive power, works at 90 strokes per minute and forces 8.76 gallons of water per minute to an elevation of 155 feet through 1,700 feet of 2½ inch delivery pipe to pump No. 1, which forces it to the shaft bottom. Besides doing the pumping, air from the compressor is used to run a small pair of hoisting engines near the Worthington pump, and two coal mining machines, one an Ingersoll-Sergeant, the other a Harrison, which work at the coal faces, about 500 feet from the Worthington pump. The air for the mining machines is conveyed to them through 1½ inch pipe.

In commenting on this plant, Mr. Brown says:

"It has been often stated that compressed air is a wasteful power and shows a low percentage of useful efficiency. I can hardly think that such would be found to be the case with our plant. I have not had time to make any calculation of the horse-power applied, and the useful horse-power obtained in our case. I only know that our compressor is a small affair, but does a big amount of work, considering the great distances between the source of the motive power and its points of application.

"In the matter of air used, I should like to say that our No. 1 pump uses 70 cubic feet of free air per minute; the air hoist at full work uses 608 cubic feet; and the two coal cutters, working at 200 strokes each per minute, use 157 cubic feet; a total of 835 cubic feet per minute. As the Ingersoll catalogue only claims that our compressor should compress 798 cubic feet per minute, it appears that the compressor is well up to its work. Of course the delivery of 835 cubic feet per minute cannot long be maintained, but it can be depended on for a 'spurt' when desirable.

"The question of pressures is interesting. With a steam pressure of 62 lbs. at the boiler, and the engine going at 83 revolutions per minute, we get a pressure of 80 lbs. of air in the receivers at the compressor, and from 81 to 82 lbs. of air in the receiver at No. 1 pump; and practically 80 lbs. at No. 2 pump, 6,149 feet distant from the compressor.

"With a temperature of 28° Fah., at the intake on surface, 43° in the air at pit bottom, and 51° at No. 1 pump, we find the exhaust from that pump to be 30° at the distance of 12 inches from its exit, and 2° below zero at 2 inches from the exit.

"I may add that the consumption of fuel by the boiler which actuates the compressor averages 248 lbs. of slack coal per hour worked."

In considering the question of compressed air for pumping, Mr. H. S. Poole, of Stellarton, Nova Scotia, asks the question, "Is full advantage taken of the compressed air as at present generally applied?" and replies—"Judging from my own experience, I should say, far from it." Continuing, Mr. Poole, judging by the result of enquiry and some experience, says, "I am now satisfied that the majority of users of air, in Nova Scotia, are more wasteful than they suppose, and that a consideration of the question cannot but be beneficial." He therefore offers the following five points for the consideration of engineers:

"1. It is evident that the clearance in the cylinders of direct-acting steam pumps, often 12 per cent. of the stroke, represents a large loss.

"2. It is very possible the ports also are unnecessarily large.

"3. It may be that where the mine water has a temperature above 60° Fah., as in deep coal pits, a water jacket would raise the mean temperature of the cylinder and reduce the tendency to make ice in the cylinder and ports.

"4. Then if the air cylinder and the water plunger be not proportioned to the work to be done, and the air has to be throttled down to the required pressure, it is clear there is a loss in consequence of the cooling of the air, unless the throttling is done at such a distance from the pump that the compressed air can recover from the surrounding air the heat which it has lost.

"5. The prints in catalogues of compressors seldom show (I have yet to see one that does show) the inlet taking air otherwise than from the compressor house, and yet as the air in the house is always warmer, and generally also more moist than the external air, the loss incurred from so taking the air is well worth looking after. At 60° Fah. a difference of 5° is equal to 1 per cent. of the coal consumption, while the actual difference of the mean of the year cannot be less than 20°, or equal to no less than 4 per cent. of the fuel consumption in favor of taking in air through a properly constructed duct free of dust."

Mr. Chas. Fergie, of Westville, N. S., in stating his experience with the air compressing plant at Drummond colliery says:

"The underground pumps at this colliery until quite recently were driven by steam taken from the surface along an incline having a pitch of 16 degrees and some 4,200 ft. in length.

"In consequence, however, of the loss of power in carrying steam that long distance, the great heat produced in the pipe road and pump room, the latter 110 F., the bad effect of heat and moisture on the roof and sides of the roads, and consequent expense of maintaining the same in a safe and satisfactory condition, the interference of heat with the ventilating currents, and the many other sources of trouble due to the use of steam underground, led the management to substitute compressed air for steam as the motive power at the pumps."

Mr. Fergie's experience at first was rather unsatisfactory, but by making certain changes he has been able to secure better results than were formerly obtained, by the use of steam. The compressor used at Drummond mine is a duplex 14″x 22″ Rand with steam expansive cut off, Halsey's positive air valve motion, and the cylinders are water jacketed. The boiler pressure is 110 lbs. and steam is cut off in the cylinder at ¼ stroke. The air supplied to the compressors is taken from outside the compressor house.

The compressors were purchased with a guarantee to drive two separate pumps at the same time, and each capable of throwing 40,000 gals. in a shift of eight hours, one against a vertical head of 600 ft., and the other against a head of 300 ft. These pumps were the steam pumps already in use. One, known as No. 9 pump, is a duplex compound straight line pump, with cylinders 8 and 14 in. x 18 in. stroke; clearance ½ in. at each end; plungers 4½ in. This pump has the 600 ft. head to force against. The other, known as No. 11 pump, is a single straight line plunger pump, 14 in. cylinders by 12 in. stroke; clearance ½ in., and plungers 5 in. This pump works against a head of 300 ft. The air was conveyed through the old steam mains, which were 5 in. diameter for one-fourth the distance, and 4 in. for the remainder.

The first trial of the air was made on the No. 9, or compound pump, using the low pressure cylinder only. With an air pressure of 95 lbs., and a piston speed of 60 ft. per minute, the pump did its work satisfactorily. In consequence of the cylinders being out of proportion to the water ends at that pressure, the air had to be wire drawn.

The other pump was then started up to work at the same time as the No. 9, but a sufficient speed to throw the stipulated quantity of water could not be maintained, and the pressure fell from 95 lbs. to 36 lbs. at this pump, and to 43 lbs. at No. 9 pump. The pressure at the surface fell to 40 lbs., the speed of the compressors remaining at 85 revolutions.

The two pumps were run together for three or four days, but the work was far from satisfactory, as it took 16 hours, instead of 8 hours, to pump out the water, and considerable difficulty with freezing was experienced. To overcome the freezing, receivers were placed, one close to each pump. This resulted in considerable improvement, but did not altogether prevent the freezing. No. 9 pump was then run alone, with a steady pressure at the surface of 85 lbs., but wire-drawing the air at a point about 300 ft. above the receiver, with a view of allowing the moisture to drop before reaching the pump. This prevented the freezing. Indicator diagrams showed that the compressor engines developed 128.49 H. P., as against 16.45 H. P. at the pump, a useful effect of only 12¾ per cent.

A similar test with No. 11 pump running alone showed an indicated H. P. at the compressor engines of 83.13, and at the pump 10.77, a useful effect of 13.11 per cent.

Having got over the difficulty of freezing, attention was then turned to the more economic problem of finding out by what means the two pumps could be run at the same time and the water taken out in the stipulated eight hours, and without making any change in the cylinders of the pumps, which are out of all proportion to their work when using air, having been built for low pressure steam. To do this it was decided to try compounding with the No. 9 pump. This, however, was not successful as a steady pressure of 75 lbs, with 90 revolutions of compressors could not be maintained, and indicator cards showed that though there was an average pressure of 62 lbs. in the high pressure cylinder, after release it fell to an average of 6.28 lbs. in the low pressure. The effect of introducing "live" air into the exhaust chamber connecting the high and low pressure cylinders, was then tried and proved successful, notwithstanding that by so doing considerable back pressure was thrown on the high pressure cylinders. This also gave a more uniform stroke of the pumps.

Indicator diagrams were then taken both at the compressors and pumps, and showed that the useful effect by the above change had been increased from 12¾ per cent to 25.93 per cent.

Commenting on his figures, Mr. Fergie makes the following observations:

"There is no question that this useful effect can be considerably further increased by making use of pumps properly proportioned to their work and expressly designed for the use of compressed air, and of the rotary type. The exhaust ports should be large and as straight as possible and the air should be exhausted above and below.

"An interesting feature observed by admitting 'live' air into the exhaust passages, as mentioned, is that all traces of frost around the exhaust passages disappear. This is no doubt due to the expanding air taking up heat from this 'live' air introduced.

"Speaking of freezing at the motor, it may be mentioned that glycerine has a most beneficial effect in its prevention.

"The great objection to the use of straight line pumps is in the large amount of clearance to be found in the cylinders; also that such a pump seldom makes two consecutive strokes alike, and that it is impossible to make use of any expansive force there may be in the air and cut-off before the end of the stroke. In the No. 9 pump above referred to the length of the stroke varies all the way from 16¾ inches to 18 inches, according to the conditions under which it is working. Considering these imperfect conditions it is no wonder that so small a percentage of useful effect is found in mine pumps using compressed air.

"The question may be asked: 'Is air as economical as was steam, considering that only 25¾ per cent. of the work developed in the compressor engines can be shown at the pumps?' In this particular case it certainly is, and as a matter of fact 1 ton 8 cwt. less coal is now being consumed in 24 hours than was the case with steam to do precisely the same work.

"There is also the beneficial effect of introducing cool air into the mine and the saving of expense in repairs due to the injurious effects of steam on the roads, etc. The pipe line is not nearly so costly to maintain as with steam, and so much steam sent into the mine means so much extra water to be pumped.

"Another important advantage gained at the 'Drummond' by introducing compressed air is that the total volume of air circulating through the mine has been increased by 16,800 cubic feet per minute.

"This increase is not due to the amount of air delivered by the compressors, but from the fact that when using steam the No. 2 slope could not be used as an intake, whereas now both Nos. 1 and 2 slopes are intakes."

THE UTILIZATION OF SMALL SIZES OF ANTHRACITE.

THE rapid increase in the utilization of the small sizes of anthracite during the past few years has been remarkable. In his annual report to the Board of Directors of City Trusts of Philadelphia, Mr. Heber S. Thompson, engineer of the Girard estate, analyzes the shipments from collieries on the Girard estate, from 1863 to 1895 inclusive, and a study of his tables furnishes the following interesting data:

From 1863 to 1866 inclusive, the smallest size of anthracite coal sent to market was chestnut, and the proportion of chestnut coal shipped ranged during those four years from 8.2 to 10 per cent. of the total shipments. In 1867 there were 1,800 tons of pea coal shipped or 0.34 per cent. of the total, and the percentage of chestnut coal shipped rose to 12.17 per cent. In the eleven years from 1867 to 1877 inclusive the proportion of pea coal shipped to market ranged from 0.34 per cent. to 9.3 per cent. of the total, and the percentage for 1877 stood at 9.19. In the same years the shipments of chestnut coal ranged from 11.19 to 14.51 per cent. of the total, and stood at 13.68 per cent. for 1877.

The shipment of buckwheat coal commenced in 1878, when 696 tons or 0.07 per cent. of the total shipments were sent to market. In the same year the shipments of chestnut coal were 12.52 per cent. of the total. From 1878 to 1894 inclusive no sizes smaller than pea coal were shipped. During this term the shipments of chestnut coal constituted from 9.44 to 20.15 per cent. of the shipments, the smaller percentages being shipped in 1882 and the larger in 1894. During the same period the percentages of shipments credited to pea coal ranged from 9.44 to 20.15, the lowest percentage being credited to the year 1892 and the highest to the year 1894.

During the same period the shipments of buckwheat coal ranged from 0.07 per cent. to 15.13 per cent. From 1884 to 1888, inclusive, there was practically no gain in the shipments of buckwheat coal, which for these five years averaged 5.76 per cent. of the total shipments. From 1888 to 1894 the percentage of buckwheat shipped jumped from 5.67 per cent. to 15.13 per cent. of the total. In 1895, 50.64 per cent. of the shipments were of coal larger than chestnut, 20.31 per cent. was chestnut, 16.54 per cent. was buckwheat, and 1 per cent. was rice coal. During the period from 1865 to 1895 the shipments of coal larger than chestnut dropped from practically 90 per cent. to 50.64 per cent. of the total. In 1895 the percentages of the various sizes were as follows:

Lump	3.60
Steamboat	8.57
Broken	10.42
Egg	10.90
Stove	17.15
Chestnut	20.31
Pea	11.51
Buckwheat	16.54
Rice	1.00
Total	100.00

In commenting on these figures Mr. Thompson says:

"The remarkable decrease in the percentages of large sizes and increase in the percentages of small sizes of coal shown by these tables is the result of two causes operating together, viz., first, the change by furnaces, iron mills and steam vessels, formerly using lump and steamboat sizes of anthracite, to the use of bituminous coal, the breaking of these large sizes of anthracite into stove and other small sizes for domestic use and the incidental production thereby of the very small sizes of buckwheat and rice coal; and, second, the increased favor with which the use of the smallest sizes of anthracite is regarded, following improvements in mechanical facilities for their handling and use in base burning stoves and by automatic stokers."

Of the total production of the eleven collieries on the Girard estate in 1895, 196,293 tons, or an amount equivalent to 13.18 per cent. of the shipments, were consumed in operating the collieries. This coal was mostly of rice and buckwheat sizes, and some of the larger sizes known as "slate picker stuff," which is "bony" coal and coal streaked with slate, unattractive in appearance, but not inferior for practical use. The eleven collieries on the Girard estate are representative ones, therefore the proportions given as to the shipment of small sizes to market are practically the same as the proportions for the whole region would be, if the same class of figures were available for the whole region.

THE NEW PRESIDENT OF THE L. C. & N. CO.

THE selection of Mr. Lewis A. Riley as president of the Lehigh Coal and Navigation Co., vice Mr. Calvin Pardee, who resigned so as to devote more of his time to personal interests, is a remarkably good one.

Mr. Riley is by profession a mining engineer and he is thoroughly familiar with the management of anthracite collieries. Since 1864, when as a very young man he became a member of Messrs. Harris Bros.' engineer corps at Pottsville, he has been directly connected with the anthracite coal industry, either as a mining engineer or an operator. Coupled with his practical experience in mining, he possesses fine executive ability and good business judgment. These qualifications eminently fit him for the position of executive head of one of the great anthracite companies. We sincerely congratulate him on the honor of his selection and also the directors of the company on their wise choice.

PERSONALS.

Mr. G. W. Bird has been appointed superintendent of the Savanna Coal Mining and Trading Co., at Savanna, Indian Ty.

Mr. Alex. Dick, manager of the Joggins mines, Nova Scotia, was a recent visitor to our offices, accompanied by Mr. John B. Law, superintendent of the Old Forge Coal Co., and Newton Coal Mining Co. of Pittston, Pa.

The Johnson Coal Co. of Scranton, Pa., has placed an order with Mr. Jos. R. Wilson, Mutual Life Bldg., Phila., for a 400 H. P. "Climax" boiler for the utilization of the waste heat from twelve cylinder boilers.

Mr. Wm. Mason, manager of the Scranton station of the Atlantic Refining Co., has been transferred to an extended field in New York State. Mr. L. W. Chase, manager of the Wilkes-Barre station, has assumed the management of the Scranton station.

Mr. Wm. H. Booth, who on several occasions, contributed valuable articles to our columns, has resigned his position of managing engineer for the Le Grand and Sutcliff Artesian Co., and has taken offices at Picadilly Mansions, No. 17 Shaftesbury Ave., London, W., England. He will in the future do a general engineering business, and make specialties of steam engineering, water supply and electrical transmission of power, paying special attention to artesian work, questions of hydrogeology, electric transmission and the introduction of good American patents to manufacturers and financiers in great Britain. He will be glad to receive all American catalogues and is desirous of taking up the representation of good American houses, his offices being central.

Mr. S. W. Douglass, mining engineer, of Ashland, Pa., who has had twenty-five years successful experience in mining engineering and prospecting with diamond drills, announces that he is prepared to do surface tracing and prospecting with diamond drills for coal, phosphate, iron and other minerals, and to prepare accurate maps, sections and reports, showing the location of veins and value of deposits. In his long experience Mr. Douglass has done satisfactory work in drilling, surveying, etc., for the following prominent concerns: Lehigh Valley Coal Co.; The Santa Fe R. R. Co.; Panama Canal Co.; Croton Aqueduct; Locust Mt. Coal Co.; Philadelphia & Reading Coal & Iron Co.; Virginia Mining Co., and many others. We can heartily commend Mr. Douglass to any of our readers requiring his services, as a thoroughly competent engineer and prospector, our acquaintance with him having been of an intimate nature and of over twenty years duration.

Prof. Justus Mitchell Silliman, M. E., of Lafayette College, died at his home on the college campus at Easton, Pa., on the 15th ult., after a few day's illness. He was born at New Canaan, Conn., Jan. 25, 1842. He served three years in the United States army during the Rebellion, and from 1865 to 1870 was a teacher at the Troy (N. Y.) Academy, at the same time taking a course in Rensselaer Polytechnic Institute. In 1871 he went to Lafayette College as an instructor, and for a quarter of a century held the chair of professor of mining engineering and graphics. He was a fellow in the American Association for the Advancement of Science, and a member of the American Institute of Mining Engineers.

Professor Silliman, though strict and exacting in the class-room, resulting in a high grade of work among his students, was an advocate of all that conduced to make college life pleasant. He encouraged athletics by his presence, and took pleasure in the successes of the college students in this line. He frequently conducted expeditions of his students into the coal fields for the purpose of giving them practical work in mining engineering, and at all times showed himself warmly interested in their success. He was active in church work and a much esteemed citizen. He is survived by his wife and two sons.

COMPRESSED AIR HAULAGE.

Description of the Plant at the Susquehanna Coal Co's. No. 6 Colliery.

Some Novel Features Peculiar to This Plant Which Successfully Meet Conditions Existing in Many Coal Mines.

Written for THE COLLIERY ENGINEER AND METAL MINER.

Some months ago we published a brief description of the compressed air locomotive at the Susquehanna Coal Company's No. 6 colliery, Glen Lyon, Pa. That description, owing to the fact that the haulage plant had just been installed, was rather incomplete, and there were several statements in it that were somewhat misleading. Through the courtesy of Mr. J. H. Bowden, Chief Engineer of the Susquehanna Coal Company, under whose supervision the plant was installed, and whose ideas incorporated in some portions of the plant materially increased its efficiency, we are able to give our readers a detailed description of the plant and a record of what it is accomplishing.

The Susquehanna Coal Company's No. 6 colliery is located at Glen Lyon, Luzerne county, Pa. It is one of the largest collieries in the Wyoming region. The mine openings consist of a shaft, a slope, and a water level tunnel. The output of the three openings, which is prepared in one breaker, amounts to about 350,000 tons annually.

The compressed air locomotive is used in the shaft workings. Fig. 1 shows a plan of the air pipe line and haulage road, together with a profile of the haulage road. By referring to Fig. 1, the outside arrangement of the buildings can be understood by the following reference letters: *A*, is the shaft; *B*, the compressor house; *C*, the carpenter and smith shop; *D*, the boiler house, and *E* the timber plane engine house. The air pipe from the compressors to the head of the shaft is 291′ 10″ long; the length of pipe in the shaft is 728′ 2″, and the length of pipe from the foot of the shaft to the end of the pipe line is 3,349′, making a total length of air pipe of 4,369′. By referring to the plan, Fig. 1, three charging stations marked *F*, *G* and *H* will be seen along the haulage road. The first of these charging stations *F*, is 112 yards from the foot of the shaft, and the second *G*, and the third *H*, are 437 yards and 1,116½ yards from the foot of the shaft. The pipe line ends at the third charging station *H*, but the end of run for the locomotive is 217 yards further in the gangway, at *I*.

The track over which the locomotive runs is shown by solid lines in the gangway, (see plan, Fig. 1), and is 36″ gauge. About 400 feet from the shaft it makes a turn of a half circle through a tunnel by two right angle curves of 23 feet and 35 feet radii, respectively, with a 70 foot tangent between. The balance of the track is comparatively straight, and all the curves are of easy radius.

By reference to the profile of the track, it will be seen that there is an average grade of 1.07%, and a maximum grade of 2.8% in favor of the load. The following table shows in detail the grade of track, beginning at the foot of the shaft:

+1.63 per cent. for	300 feet.	+0.61 per cent. for	200 feet.
+1.21 " "	132 "	+1.04 " "	150 "
−.84 " "	363 "	+0.71 " "	100 "
+2.0 " "	200 "	+0.5 " "	250 "
+.75 " "	100 "	+1.09 " "	100 "
+1.79 " "	150 "	+0.24 " "	100 "
+.63 " "	150 "	+0.64 " "	150 "
+1.51 " "	100 "	+1.76 " "	250 "
+.47 " "	150 "	+2.79 " "	100 "
+1.5 " "	200 "	+1.37 " "	100 "
−0.06 " "	100 "	+2.39 " "	100 "
+0.61 " "	100 "	+0.7 " "	100 "
+1.04 " "	150 "	+0.38 " "	113 "

The air compressor used (shown in Fig. 2) is a three-stage compressor built by the Norwalk Iron Works, South Norwalk, Conn. The air is drawn into an intake cylinder 12½″ diameter with 24″ inch stroke, shown near the center of the machine, where it is compressed to a comparatively light pressure and delivered hot into one of the intercoolers, shown on top of the machine, consisting of an iron casing filled with thin copper tubes, through which cold water is constantly circulating. In this intercooler the air parts with the heat attained by the first compression. It then passes to the second compressing cylinder, 9¼″ diameter, in which it is further compressed, sent on through a second intercooler, and finally further compressed to its final pressure of 600 pounds per square inch, in a third cylinder, 5″ diameter, from which it is delivered to the line pipe, which forms a receiver, 5″ diameter, and 4,369 feet long, as well as a conductor for the air. All the air cylinders are water jacketed, to assist in reducing the temperature of the air during compression, and are of very solid construction. The air valves are of special design, forged in one piece to prevent any part working loose, and valves and seats may be removed from the outside of the machine for adjustment and repairs. The steam cylinder of the compressor is 20″ diameter by 24″ stroke, provided with a "Meyer" cut-off valve, and it is directly connected to the three air cylinders which are all of the same stroke, and also connected to the two large and heavy fly-wheels shown. The entire mechanism is mounted on one heavy bed plate, making a very smooth running machine.

As the atmosphere in the vicinity of collieries is usually charged with a considerable amount of dust, the air is supplied to the compressor through a washer designed by Mr. J. H. Bowden, by means of which all dust and grit are removed from it before compression. This results in a great saving of wear on the valves, cylinders and other rubbing surfaces of both the compressor and locomotive, and prevents enlargement of leaks caused by dust in the air, which, under the high pressure used, cuts like a sand blast.

The capacity of the compressor is 275 cubic feet of free air per minute compressed to 600 pounds per square inch, with the compressor running at 100 revolutions per minute. As this quantity is more than sufficient for two locomotives, the compressor is operated at an average speed of only about 40 revolutions per minute, the speed being controlled by an automatic regulating valve, which allows a speed just sufficient to maintain the required pressure in the air main. As mentioned before, the air from the compressor goes to a line of 5″ wrought iron pipe 4,369 feet long. Attached to the pipe line at the foot of the shaft is a heavy cast tee with several feet of pipe below it to collect any condensed moisture; the bottom of the separator thus formed being provided with a water waste valve. At each of the three charging stations along the gangway, there is a gate valve in the main pipe, which enables any section to be cut off in case of accident, and the air can be blown off to permit of repairs without the necessity of blowing off the entire main and consequent stoppage of work, and saves the time required for pumping up the entire main to 600 pounds.

The 5″ main has a capacity of 580 cu. ft. of air at 600 lbs. pressure, equivalent to 23,000 cu. ft. of free air. The use of the pipe itself as a reservoir is a novel feature of the plant, dispensing with large and costly receivers underground, and admitting of as many charging stations as may be desired, and their location at any point along the main. The size of the pipe was naturally determined by the length of the line and the required reservoir capacity. Extensions can be made with much smaller pipe drawing from the large pipe as a reservoir. The pipe used was purchased from the American Tube and Iron Co., and each length was tested to 1,500 pounds per square inch before shipment. The majority of the joints are coupled by the extra heavy wrought coupling, shown in Fig. 3, the ends of which are counterbored to allow caulking with lead or copper if desirable.

At all the charging stations and special castings, as well as at intervals of two hundred feet along the line, flange couplings as shown in Fig. 4 are used. These consist of heavy cast flanges 12″ diameter and 2¼″ thick, with finished faces, rough bored to take the pipe, which is then expanded into them by a special tube expander. The ends are riveted into the recess shown and are hammer-faced flush with the centerbore. The flanges are counterbored 1/16″ deep and 7″ diameter to retain the gaskets which are of lead or "Vulcanized Fibre."

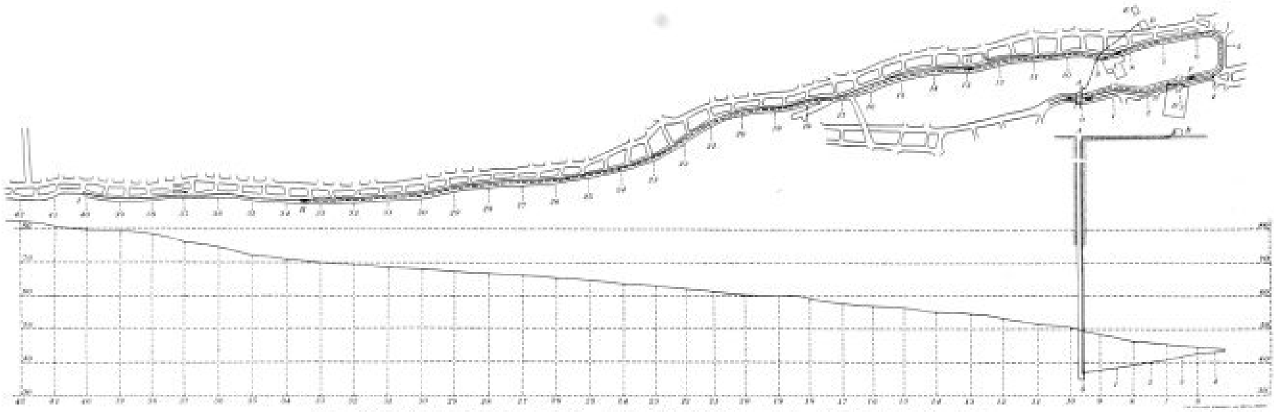


FIG. 1. PLAN AND PROFILE OF HAULAGE ROAD. HORIZONTAL SCALE 1 IN. = 400 FT. VERTICAL SCALE 1 IN. = 40 FT.

The charging connections as shown in Fig. 5 consist of a cast tee on the main pipe with 1½″ opening on which is placed a heavy gate valve *A*, and a right angle flexible coupling *B*, with a sufficient length of extra heavy 1½″ pipe ending in a half screw coupling *C*, to reach the charging pipe of the locomotive. The latter contains two flexible joints, *D* and *E*, and with the other half of the screw coupling, the whole is so flexible that a considerable latitude is permissible in stopping the locomotive in position to connect to the charging pipe. As will be seen by reference to Fig. 5, there is a combination check and stop valve *F*, on the locomotive. The whole operation of charging the locomotive consumes but 1½ minutes, and reduces the pressure in the main from 600 to about 570 pounds. On the outlet side of the charging gate valve is a ⅜″ bleeder valve, *H*, which is used to exhaust the compressed air from the coupling pipe after charging and before the screw coupling is opened. The pneumatic locomotive shown in side and end views in Figs. 6, 7 and 8, consists essentially of a 7″ x 14″ cylinder locomotive with the boiler replaced by air storage reservoirs. It is 62 in. wide, 60 in. high, and 17′ 6½″ long over the bumpers, and weighs 18,400 pounds. The port openings in the cylinders were specially designed for the use of compressed air, being much larger than the standard for steam locomotive practice, with the result that there is practically no back pressure in the cylinders, and no trouble has been experienced from freezing in the exhaust. The air for propelling the motor is stored in two large steel tanks, located between the cylinders, on a saddle, much after the manner of a steam boiler. These tanks are built for a working pressure of

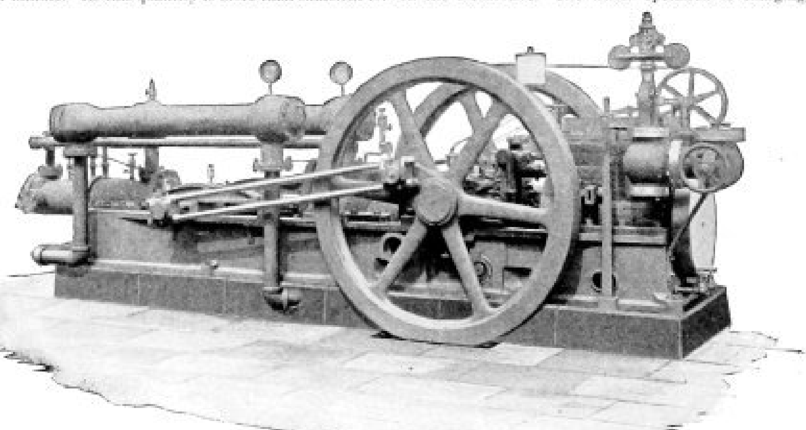


FIG. 2. NORWALK THREE-STAGE AIR COMPRESSOR.

600 pounds per square inch, and were tested to hydraulic pressure of 1,000 pounds before being placed in service, and made absolutely tight under this pressure. Convex heads are placed at both ends of the storage tanks, the front heads being furnished with large manholes reinforced with steel castings, and all connections screwed into the tanks are reinforced with cast steel flanges. All parts carrying pressure were tested to from 35 to 50 per

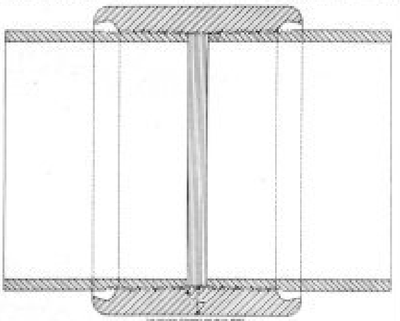


Fig. 3. Heavy Wrought Iron Joint Coupling.

cent. above working pressure, and are absolutely tight at such pressure.

The tanks are constructed with a large factor of safety, and are so designed as to insure absolute safety at a much higher working pressure than they are designed to carry. The air from the two main storage tanks is conducted through connections to an auxiliary reservoir of much reduced diameter, placed below and between them. The pressure in this auxiliary tank can be regulated anywhere from 30 up to 140 or 150 pounds, as required, the air being reduced from the main storage tanks by a specially designed reducing valve, which can be regulated to any pressure at a moments notice, and when

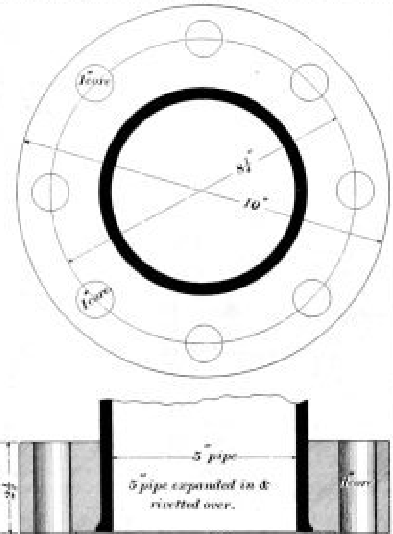


Fig. 4. Cast Iron Flange Coupling.

once set maintains a constant fixed pressure in the auxiliary reservoir, thereby preventing any undue waste of air by injudicious handling, etc. In case only light loads are to be handled, the pressure can be materially reduced on the auxiliary reservoir, thereby securing a decided gain in the economical use of the air; or, on the other hand, in emergencies almost any pressure can be at a moment's notice utilized, and this without any undue heating or loss. In the auxiliary reservoir the air is controlled by a specially designed differential throttle, admitting the air to the cylinders.

The motor at present in use has a capacity for hauling a trip of 16 empty cars from the foot of the track, 3,700 feet in to the gangway and a trip of 16 loaded cars back to the foot of the shaft with one charge of air, starting with a pressure of 575 pounds in the reservoirs and ending with a little over 100 pounds remaining in them, the heaviest work of course being in hauling in the empty trip up grade. The weight of each empty trip of 16 cars, including the locomotive, is about 60,000 pounds, and of the loaded trip, including the locomotive, is 166,000 pounds. The locomotive will make from 25 to 50 miles per day, depending upon the length of run and the time required for making up trips.

The cost of operation of this plant has been found to vary from one to one and one-half cents per ton-mile, including all expense, interest and depreciation of plant, varying with the character of the rolling stock used. The depreciation on the locomotive is very low, there being no boiler to wear out, and the tanks, having nothing to corrode them, should, if kept well painted, last almost an indefinite time. In this case the condition of the car wheels owing to spragging is bad, there being

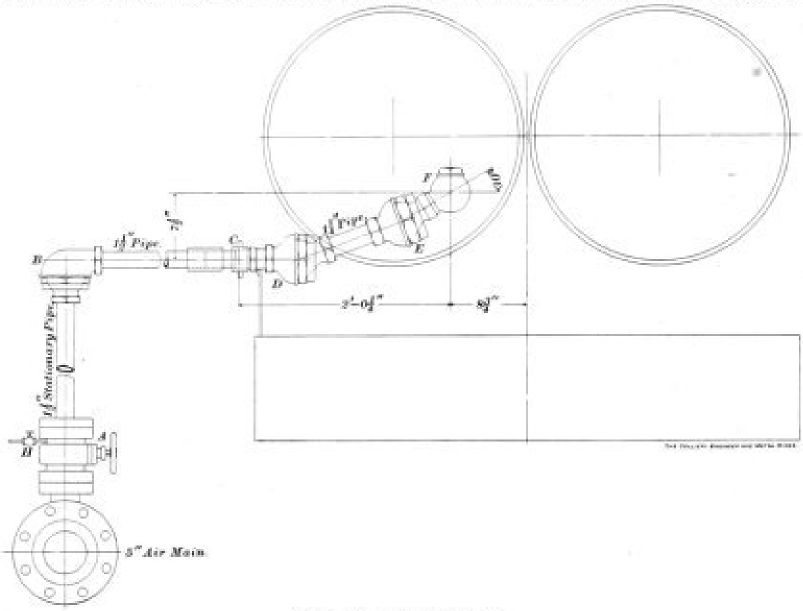


Fig. 5. Recharging Connections.

many flat spots caused by sliding, and the frictional resistance per ton on the track is excessive, but these cars are gradually being equipped with self-oiling wheels and brakes, similar to those in use at the Nanticoke collieries, which wheels give good lubrication and low frictional resistance, while the brakes besides being much more easily handled than sprags, give absolute immunity from flat wheels. When this change, which was commenced only a few months before this haulage plant was put in operation, is completed, it is expected that the cost of haulage by this system will be still further reduced.

Compressed air haulage, of which this is the first example in the anthracite regions, has much to recommend it, being cheaper than wire rope haulage except perhaps under the most favorable conditions for the latter, and very much more flexible, as the locomotive has a considerable radius of operation beyond the charging stations and can run anywhere on the track without previous preparation, provided only that there is sufficient room for it. Extensions of the pipe line are easily and cheaply made, and its absolute freedom from fire puts it beyond comparison with electric haulage or steam locomotives in gaseous mines, and indeed anywhere where avoidance of danger from fire is of importance.

The Susquehanna Coal Company intends very shortly to put another pneumatic locomotive in service in this colliery, using the present compressor, and the 5 inch pipe line as a reservoir and extending a three inch line about 4,000 feet with three charging stations, to supply the new locomotive.

As will be seen by reference to Fig. 1, the compressor is located on the surface, and receives its steam supply from boilers which were previously installed for operating other engines. The compressor house and the engine house for operating the timber plane are close together, and one engineer operates both the hoisting engine for the plane and the compressor. Owing to the compressor being controlled by the pressure regulator, it requires very little attention.

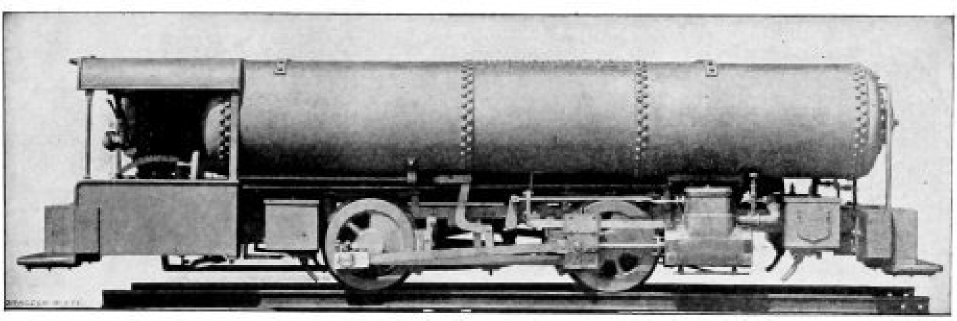


Fig. 7. Side View of Locomotive.

Compressed air haulage is being recognized more and more as a successful competitor for public favor, both as a means of transmitting power and operating machinery.

Messrs. H. K. Porter & Co. have for a long time advocated the use of compressed air motors for mine haulage, surface railways and other places where steam power is not desirable, and they have installed a number of successful plants. Compressed air especially commends itself on account of economy, perfect safety, simplicity in operation, convenience in handling, and freedom from delays due to break-downs, etc. The light repairs required, cost of maintenance and freedom from fire of any character, specially commend compressed air for haulage for mine service, particularly where much gas is encountered.

Its economy is determined by the cost of installation, cost of operating, mileage and tonnage. The cost of maintenance of the locomotive, including depreciation and repairs, should not exceed 4½ %. This figure may

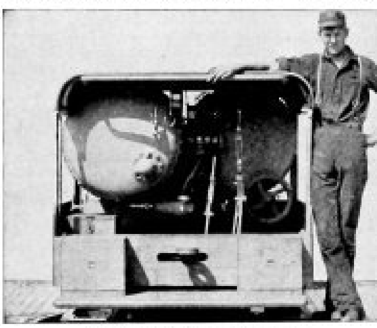


Fig. 6. Rear View of Locomotive.

appear rather low, but when it is considered that the only parts requiring replacing are a few wearing surfaces, such as rod and driving box brasses, link motion, etc., there is very little to require replacement. The tanks and all connections, if given a coat of paint occasionally, should last an indefinite period, as they are not exposed to the corrosive action of water and fire, and are not subjected to constant expansion, contraction, etc., which is always the case with steam boilers.

Before this plant was installed Mr. Bowden, in company with Mr. George T. Morgan, superintendent of the Susquehanna Coal Co.'s collieries, visited H. K. Porter & Co.'s locomotive works, at Pittsburg, Pa., and one of W. H. Brown's Sons' bituminous mines in the Monongahela valley at which a "Porter" compressed air locomotive, using 300 lbs. pressure, was in use. Then, with the assistance of Mr. E. P. Lord, superintendent for H. K. Porter & Co., this plant was designed and installed.

Since the above article was written, we are informed that the Susquehanna Coal Co. has given Messrs. H. K. Porter & Co. an order for a second locomotive and the

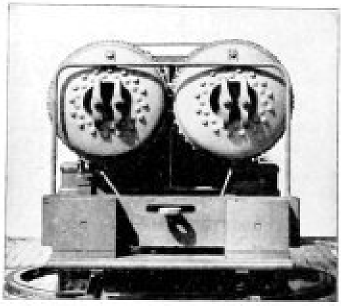


FIG. 8. FRONT VIEW OF LOCOMOTIVE.

American Tube and Iron Co. an order for 4,000' of 3" tubing for a branch line to supply the new locomotive, which is to be fitted up in a similar manner to the 5" tubing described above. This is a strong practical endorsement of the success of Messrs. H. K. Porter & Co.'s compressed air locomotives and of the American Tube and Iron Co.'s tubing.

METAL MINING.

ARTIFICIAL MEANS OF VENTILATION.

Special Conditions in Metal Mines as Distinguished From Collieries—Different Devices Used—Foreign and Obsolete Methods—Water Blowers, Tromps, Furnaces, Etc.—Compressors as Auxiliary Ventilators—Blowers—The Conditions for Use of Different Styles.

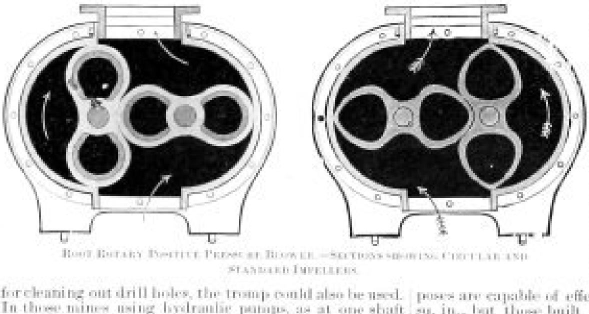
Written for THE COLLIERY ENGINEER AND METAL MINER by Albert Williams, Jr., E. M.

Where natural draft (assisted by the simple devices already described) is insufficient, metal mines require artificial ventilation, though to far less extent than collieries. As the conditions are quite different in the two classes of mines, the means employed are different, though the underlying principles are the same. Some of the appliances still mentioned in text-books as used in metal mines are obsolete, dangerous and wholly out of place in modern practice. It is worth while to notice one or two here, to explain why their use is unadvisable.

The tromp is a simple application of the injector prin-

ROOT ROTARY POSITIVE PRESSURE BLOWER.—EXTERNAL VIEW.

ciple, water falling in a pipe or cylinder carrying with it air and creating a small intake draft. The volume of air is so small as to be insignificant unless a large quantity of water is used. One of the main objects in mining being to get rid of water, it is manifestly absurd to introduce any from the surface. Occasionally there is a small flow in a shaft between pump stations which might be utilized if it were worth while; and in about one mine in a thousand, so dry that water is sent down



ROOT ROTARY POSITIVE PRESSURE BLOWER.—SECTIONS SHOWING CIRCULAR AND STANDARD IMPELLERS.

for cleaning out drill holes, the tromp could also be used. In those mines using hydraulic pumps, as at one shaft on the Comstock and one at Eureka, Nev., and a few in Europe, it is possible that part of the power water might be so used, but it is not easy to see how this could be done without interfering with the hydraulic system.

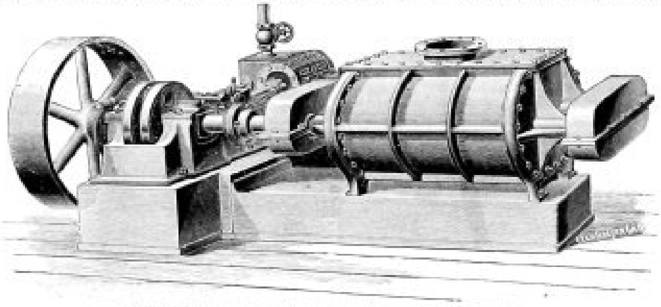
Furnaces are not used in American metal mines, and should not be. They are dangerous, even where little timber is used; not very effective, and a nuisance. It is conceivable that an exhaust pipe might be fitted from the bottom of a mine, leading to the boiler furnaces at the surface, thus creating a small upcast draft, but such an arrangement is not known.

Hartz and Cornish Water Blowers.—Where the mine has a Cornish pumping system, an apparatus worked by the reciprocating pump rod is sometimes used abroad, but not in the United States. It consists of a fixed outer tub, half filled with water (to make an air joint), and an interior moving tub with its mouth downward. A pipe leads through the bottom of the outer tub, its mouth being just above the water and its other end being at the place to be ventilated. Both tubs have flap valves of leather. The inner tub is connected to the pump rod and moves up and down with the latter. It thus forms a sort of air pump, and acts as an exhauster or forcer, according to whether the valves open upward or downward.

On this principle a very large blower, double-acting, called the Struve, has been constructed in Europe, but is not known in the United States. The objections to it are that it is cumbersome and obstructs the shaft, if the shaft is a working one. If, however, the shaft is used only as an air shaft, such a machine might be used were there not better.

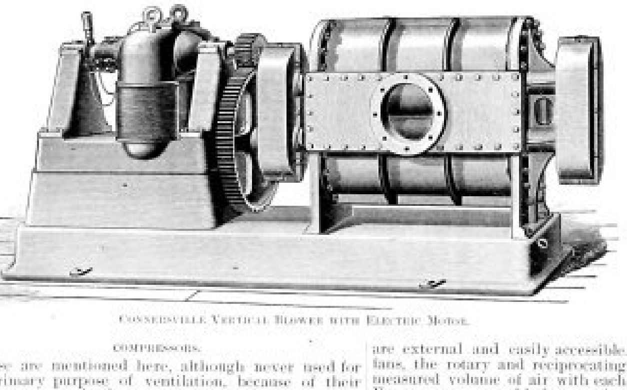
MACHINES USED IN AMERICAN PRACTICE.

These may be grouped into three broad classes: (1) compressors, (2) blowers, either rotary or reciprocating, and (3) fans of two sorts, centrifugal and propeller. Some of the fans are called "blowers" by their makers. The practical difference between the three classes is in



CONNERSVILLE HORIZONTAL BLOWER AND ENGINE ON SAME BED PLATE.

the pressure of the air and its volume (at atmospheric pressure). The mechanical differences will be seen further on. Compressors are forcers; blowers and fans can be built to act either as forcers or exhausters, and, in some of the patterns the same machine will act either way, by simply reversing the direction of rotation.



CONNERSVILLE VERTICAL BLOWER WITH ELECTRIC MOTOR.

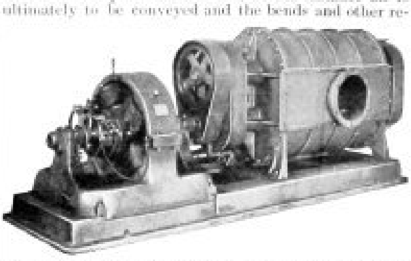
COMPRESSORS.

These are mentioned here, although never used for the primary purpose of ventilation, because of their great importance in that respect, as a secondary result. They are used to drive power drills, baby hoists and other light underground machinery, and will be described in their proper place. One advantage of compressed air ventilation in hot mines is that the exhaust from the drills, etc., in expanding to normal volume is greatly cooled. Another is that the air is delivered where most needed, at the working faces; and another is that no special attention is given to ventilation and no separate arrangement of air pipes and joints is called for or trouble about extensions of air pipes—the apparatus moving about with the advance of the workings. But there are many mines equipped with power plant which do not use air-drills, and there are others, especially very large and hot mines, which call for ventilation on a larger scale.

Compressors for special purposes are capable of effecting a pressure of 2,000 lbs. per sq. in., but those built for mine work give a comparatively low pressure, say 70 or 80 lbs.

BLOWERS.

The best blowers also produce higher pressures than are needed for ventilation, running up to ten pounds per square inch, whereas mine ventilation requires an initial pressure to be measured rather in ounces or in inches of water. The high-pressure blowers are used for blast furnaces, in iron, copper and lead smelters and cupola melting furnaces; those for mine ventilation are of less power or are driven at lower speed. It is always well to have a reserve power in a blower, as the distance air is ultimately to be conveyed and the bends and other re-



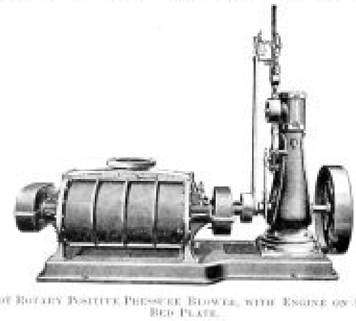
ROOT BLOWER, WITH SLOW SPEED ELECTRIC MOTOR (GENERAL ELECTRIC CO.)

sistances in the pipes are not always known in advance of the extension of the workings. This of course also applies to fan installations.

There is sharp competition between the makers of the numerous types of rotary blowers, blowing cylinders and fans. It would be improper here to compare their relative merits, and it is possible to mention only a few of the many kinds and to but briefly touch upon points of difference. The general statement is in order here, however, that excellence is by no means confined to one or even a very few of the styles of blowers and fans. Evidence of this is given by the variety of machines doing similar duty at different mines and selected by mine managers of unquestioned judgment. At the same time, intending purchasers of ventilating machinery should bear in mind the special conditions involved in the case in hand, and compare the machines accordingly. The present and probable extent of the workings, determining the volume of air and pressure needed to overcome resistance in long distance transmission, are the first points to be considered. Blowers for mine ventilation are best fitted for very large mines and extra long tunnels, and are not suited to small ones, where cheaper fans would suffice.

As compared with blowing cylinders, it is claimed for the rotary blowers that they have much greater capacity on account of the higher speed at which they may be run, for equal sizes and spaces occupied; that they have no receivers, valves or their equivalents, as are needed with piston blowers; that the wearing parts and those needing attention are external and easily accessible. As compared with fans, the rotary and reciprocating blowers discharge a measured volume of air with each revolution or stroke. For some purposes this feature gives them a great advantage, but for metal mine ventilation it is not of much importance under ordinary conditions.

This machine consists of two interlocking impellers, revolving side by side in very close connection, but

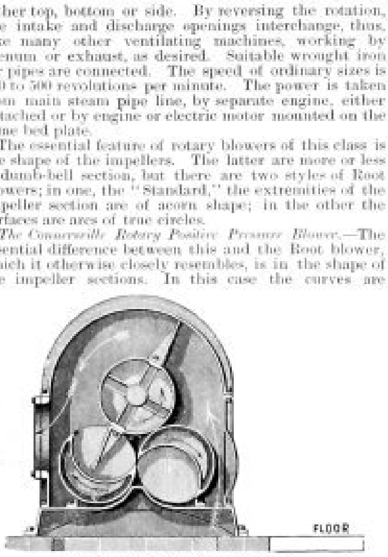


ROOT ROTARY POSITIVE PRESSURE BLOWER, WITH ENGINE ON SAME BED PLATE.

without actually touching each other or the containing case. They and the case are of cast iron accurately bored and dressed to true surface, so that while practically no air escapes there is no internal wear. They are driven by a pair of external equal gears, the only wear coming upon these gears and the shaft journals. At each revolution an equal volume of air is taken in and exhausted. The discharge opening is either top, bottom or side. By reversing the rotation, the intake and discharge openings interchange, thus, like many other ventilating machines, working by plenum or exhaust, as desired. Suitable wrought iron air pipes are connected. The speed of ordinary sizes is 250 to 500 revolutions per minute. The power is taken from main steam pipe line, by separate engine, either detached or by engine or electric motor mounted on the same bed plate.

The essential feature of rotary blowers of this class is the shape of the impellers. The latter are more or less of dumb-bell section, but there are two styles of Root blowers; in one, the "Standard," the extremities of the impeller section are of acorn shape; in the other the surfaces are arcs of true circles.

The Connersville Rotary Positive Pressure Blower.—The essential difference between this and the Root blower, which it otherwise closely resembles, is in the shape of the impeller sections. In this case the curves are

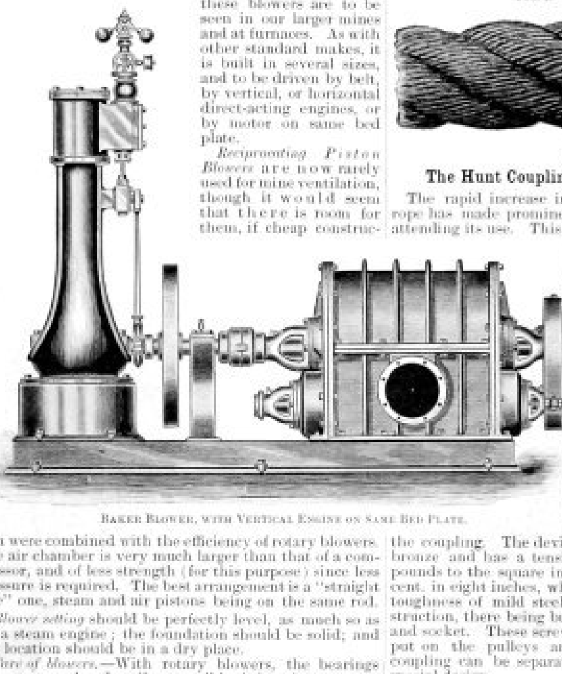


Baker Rotary Blower.—Section.

cycloidal and not arcs of circles. On this head controversy is very warm, and a just exposition of the theoretical considerations cannot be given within reasonable space. Those interested should consult the catalogues of the two companies. This form is also largely used. Two styles are made; in one, the vertical, the impellers are over each other; in the other, the horizontal, they are side by side. They are driven either by belt from separate engines or by engines or electric motors on the same bed plate.

The Baker rotary forced blast blower.—This blower stands between the impeller blowers and fans. Like the Root, the Connersville and the reciprocating piston blowers it takes and delivers a measurable volume of air at each revolution, while the blades on the main drum look somewhat like fan vanes. The action, however, is different, being positive and not dependent on centrifugal or screw action. This blower is made entirely of iron. It has no internal friction and is driven by one belt and without gear wheels. Inside the casing are three drums, each of which is a single casting, truly turned and balanced to ensure steadiness of motion. The upper drum, to which the pulley or direct acting engine or electric motor is attached, does all the work of blowing or exhausting (according to direction of revolution). The two lower drums serve as valves to prevent the air from escaping or returning. It can be driven at high speed, delivering or exhausting large volumes of air. Many of these blowers are to be seen in our larger mines and at furnaces. As with other standard makes, it is built in several sizes, and to be driven by belt, by vertical, or horizontal direct-acting engines, or by motor on same bed plate.

Reciprocating Piston Blowers are now rarely used for mine ventilation, though it would seem that there is room for them, if cheap construc-



Baker Blower, with Vertical Engine on Same Bed Plate.

tion were combined with the efficiency of rotary blowers. The air chamber is very much larger than that of a compressor, and of less strength (for this purpose) since less pressure is required. The best arrangement is a "straight line" one, steam and air pistons being on the same rod.

Blower setting should be perfectly level, as much so as for a steam engine; the foundation should be solid; and the location should be in a dry place.

Care of blowers.—With rotary blowers, the bearings being external and easily accessible, it is only necessary to see that the oil supply is abundant. They usually have good protection from dust. Several styles of self-oiling journals are in use, and in some the parts run wholly in oil. The best makes have an indefinitely long life if properly cared for.

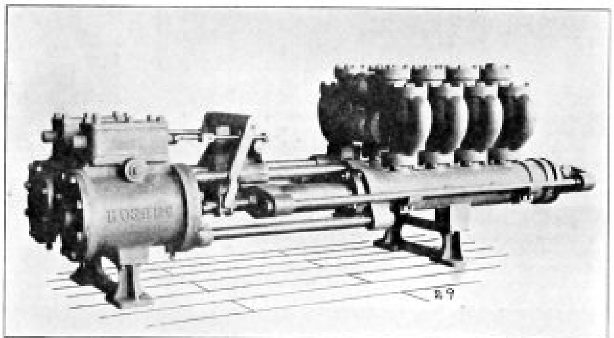
Power required.—This depends on the volume and pressure; consequently on the speed and interior air space. The rule usually followed in computing net power for given volumes at different pressures is: Multiply the number of cubic feet delivered per minute by the pressure in ounces per square inch (at the blower) and the product by .003; divide the last amount by 11; the quotient will give the net horse-power. This rule, that adopted by the makers of the Baker blower, does not include power for running belts, blower, etc., or for overcoming friction and resistance of air in pipes, for which a very liberal allowance must be made. As to power consumed in merely running the blower and belts, this is small, as the best rotary blowers run very light.

(To be continued.)

A Good Steam Pump.

We illustrate herewith a 12″x6″x12″, outside packed plunger pump, which has the valve chambers all separate. The valves are accessible through hand-hole plates. They are made of brass with leather faces. This pump will handle 300 gallons of water per minute against a head of 400 feet, with 80 lbs. steam pressure. The arms and valve gearing on this pump are made of steel, and all parts are interchangeable.

The manufacturers of this pump, the Hughes Steam Pump Co., of Cleveland, Ohio, will hereafter keep their manufactures prominently before the mining fraternity through their advertisement in The Colliery Engineer and Metal Miner. This concern is already too well known to need any special introduction here. Suffice it to say they are prepared to furnish pumping machinery for any service and up to any demand as to capacity. They have had such experience in building mining pumps as to have a thorough appreciation of the severe conditions imposed on such, and to be able to cope with such problems. The catalogue issued by the Hughes Company, (sent gratuitously to mining men) describes the various machines built by the concern, and besides, contains considerable information on matters germane to pumping machinery in convenient form for reference. Send for it.



Hughes Steam Pump, 12″x6″x12″.

The Hunt Coupling for Transmission Rope.

The rapid increase in the transmission of power by rope has made prominent one of the minor difficulties attending its use. This is the gradual lengthening of the rope which increases the sag until it becomes necessary either to resplice the rope or to use a take-up sheave with a very long range of motion. Rapid wear of the rope from slipping on the pulleys is frequently caused by lack of sufficient tension.

The Hunt Rope Coupling, which we illustrate, is designed to do away with all necessity for resplicing, etc., as it will keep a rope at exactly the right tension for the most effective service and long life, and do this with little or no extra time or attention being given the matter and with no expense other than the first cost of the coupling. The device is made wholly of aluminum bronze and has a tensile breaking strength of 60,000 pounds to the square inch, and an elongation of 20 per cent. in eight inches, which is equal to the strength and toughness of mild steel. It is very simple in its construction, there being but two parts consisting of a screw and socket. These screw together when the rope is first put on the pulleys and lock securely, so that the coupling can be separated only by using a wrench of special design.

A very important and interesting feature of the coupling when screwed together is an internal swivel and ratchet, which we show in Fig. 3. The swivel permits the joint to yield to the curvature of the pulleys while the ratchet holds the parts from revolving on each other and untwisting the rope.

The Hunt coupling is made smaller in diameter than the rope with which it is to be used, in order that it may not touch the grooves of the pulleys, even when the rope is worn.

The rope of the correct length for the drive when connected up, is spliced into the coupling, and as it wears longer, more "turns" are put into it by revolving one part of the coupling, the ratchet automatically holding all secure when the rope has the proper length and tension.

Where several independent ropes are run side by side on a pulley, all can be kept at the same tension with the greatest exactness by putting a few more turns in the slack one when such a condition is noticed. By using this coupling, in a multiple rope drive, any single rope can be taken off in a few minutes, and the work done by the remaining ones until it is convenient to put on a new rope, which can be done with equal dispatch, and, what is of greater importance, the tension adjusted to correspond exactly with the other ropes. The cost of a rope drive, with this coupling spliced in and installed in position on the pulleys, is usually less than that of ropes spliced on the spot by the purchaser in the ordinary manner, and it is also less than a rope drive with a tension pulley which, in addition to its cost, frequently requires space that is useful for other purposes. When we consider that a rope requires to be spliced two or three times during its life, while the couplings having no wear, are permanent, with no further expense after once installed, it will be seen that this method is much the cheaper, as well as the better one.

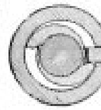


Fig. 3.

Fig. 1.—Hunt Rope Coupling Before Being Adjusted on the Pulleys.

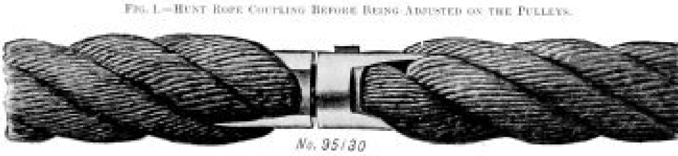


Fig. 2.—Hunt Rope Coupling Mounted on the Drive.

The advantage, both in the convenience of installation, the facility of adjustment of tension, the perfect control of the sag, and the increased life of the rope from a more equal tension, are sufficient to justify an expenditure of many times their cost.

The C. W. Hunt Company, 45 Broadway, New York City, are the exclusive licensees in the United States for the patent on this coupling, and are prepared to furnish transmission rope of the well-known "Stevedore" brand and of the usual sizes, with the couplings spliced in position.

"Hercules" Wire Rope.

With this number of the Colliery Engineer and Metal Miner the A. Leschen & Sons Rope Co. of St. Louis, Mo., begin an advertisement of the wire rope made by them. One pattern of rope of their manufacture for which special merit for mining service is claimed, is their "Hercules" patent flattened strand.

The peculiar advantage claimed for this rope is that the strands instead of being circular in cross-section, have an outer approximately flat surface, with the result that there is a plurality of wires to take the surface wear instead of one external wire as in ropes of ordinary construction. By this plan, a comparatively smooth surface is presented even while the rope is new, and the wear being distributed over a number of wires the tendency to become brittle in service is greatly lessened.

These ropes are made either with the wires in the strands and the strands in the ropes in the same direction (Lang's lay), or reversely.

The makers of this rope state that by this construction they produce a rope without any tendency whatever to spin or kink, a feature of great value when used for sinking ropes or for hoisting in tubs from ore mines.

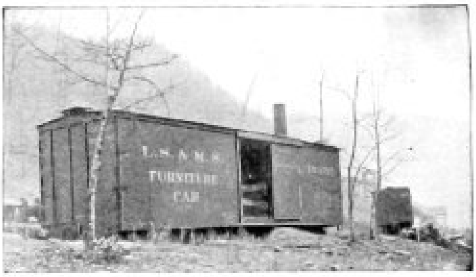
In addition to this special form, Messrs. Leschen manufacture a complete line of wire ropes of all kinds and for all classes of service. A postal card to their home office, 924 N. Main Street, St. Louis, Mo., or to their recently established branch at 19 S. Canal Street, Chicago, will secure their catalogue and detailed information concerning these ropes.

ELECTRIC MINING MACHINES.

A Novel Method of Proving Their Efficiency.

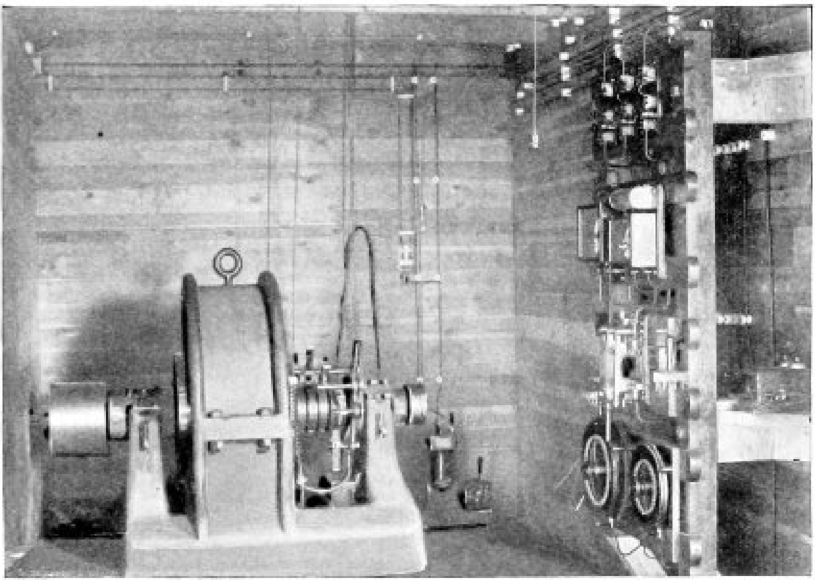
A novel scheme has recently been adopted by the Power and Mining Department of the General Electric Co., in its campaign to introduce electric mining machinery for the operation of coal mines.

The question of coal cutting by machinery, instead of by hand, is a simple one of dollars and cents to be saved by adopting mechanical methods, but conviction is difficult owing to the limited experience of operators with electrically driven machinery and the skepticism natural under such circumstances. Something more conclusive than simple argument or experience in other mines is necessary, as, for instance, a careful test under actual working conditions.



Exterior View of Car Containing Engine, Boiler, Dynamo, Etc.

But such a test would require a complete installation, and neither mine operator nor manufacturer has cared to undertake the installation of a temporary plant, necessitating considerable outlay, with only a chance of an eventual sale. This fact has consequently hitherto militated against the experiment.



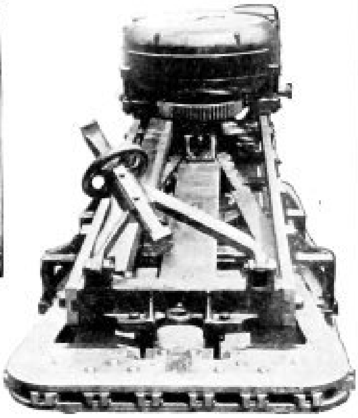
View of Interior of Car.

To enable the operator to judge from actual observation of the merits of machine mining as compared with pick mining in his own coal, the General Electric Co. has devised a complete and compact portable power plant, susceptible of installation near the mine mouth. It includes all the necessary electrical apparatus, and the operator is called upon to furnish nothing more than the water and fuel.

The generating plant occupies the interior of a box car, 40 ft. 8 in. long, 8 ft. wide and about 9 ft. high. It consists of a specially designed water tube boiler of a capacity of 40 horse-power at 100 pounds pressure, furnishing steam to a high speed automatic engine running at 300 revolutions and exhausting into the boiler flue.

The electric generator is a three-phase machine of 75 K. W. or 100 horse-power capacity, wound for 550 volts and running at 900 revolutions. It is belt driven from the engine. A small bi-polar generator serves as an exciter. Although in this case it only runs one coal cutter, it has sufficient generating capacity to supply current to a plant of five or more, the capacity, of course, depending upon the hardness of the material to be cut.

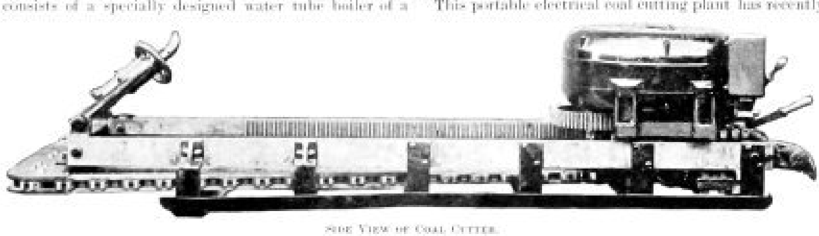
To the right of the generator is a skeleton switchboard, equipped with the necessary switches, rheostats, measuring instruments, etc.



End View of Coal Cutter.

The coal cutter, which forms a part of the plant, is the first known adaptation of the multipolar motor to the coal cutting machine. This motor is ironclad and is completely enclosed and protected from moisture and injury. It has neither commutator nor brushes and no moving contact. It stops operation as soon as it has reached the limit of its power, and thus is not exposed to accident in case of overload. Furthermore, it is sparkless, and this fact only needs attention to find full appreciation of its value from mining men.

The cutter itself is a chain machine making a cut 3 ft. wide, 6 ft. deep and 4½ inches high in about 3½ minutes; it withdraws in about 10 seconds. The capacity of the motor is 20 horse-power, but the consumption of power under ordinary conditions is between 6 and 7 horse-power.

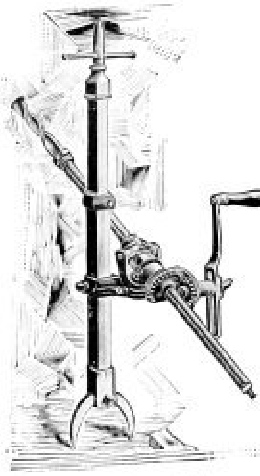


Side View of Coal Cutter.

This portable electrical coal cutting plant has recently been operating in the mines of the Peerless Coal and Coke Co. at Vivian, W. Va., where the record for machine coal cutting has been established. The amount of cutting showed the remarkable average of 7.6 runs or cuts per hour. Taking the depth of cut at 5½ feet, the width 36 inches and the thickness of the coal 5 feet, for a period of two weeks, the average weight of coal undercut per hour was not less than 23 tons. At the mines of the Sterling Mining Co., Cannelton, Pa., a contract for several of these coal cutters was given to the General Electric Co. after exhaustive examination of the multiphase system in operation. It was awarded in face of the most severe competition and also in face of the fact that Mr. W. H. Warner, the general manager of that company, had been using for a number of years a mine plant operated by direct current.

McNelly Coal Drills.

The accompanying engraving, and that in the advertisement of W. A. McCune & Co., of Sterling, Ill., illustrate patterns of the McNelly patent coal drills recently put on the market by the firm named.



The salient features of these machines are the telescope pipe posts, with sliding bridge and jack screws to compensate for settlement in soft floor. The double post drill shown in advertisement is of special advantage in close work, as with side-gear a hole can be driven within two inches of the rib. The gear can be used on either side, on top, or directly under the driving screw, and can be changed from one position to another almost instantly.

The square pipe post drill shown herewith is the same as the double post, save in the post itself.

The McNelly square pipe grip drill in its parts is the same as the post drills, except that a grip post is substituted for the vertical post. By ordering a grip post with either of the two drills first described the miner can have two complete machines at nearly the cost of one.

Full descriptions of these machines, prices, capacities, etc., are given in a circular of the manufacturers above named, and which will be sent free on application.

Fighting Mine Fires by Direct Process.

Experience with mine fires has proven conclusively that the most effective work can be done by the direct process, if the fighters are able to approach the location of the fire with safety. The Vajen & Bader Co., of Indianapolis, who primarily put forth the Bader patent fireman's smoke protector, as a means to enable firemen to enter and work in burning buildings regardless of smoke and gases of combustion, and in which use it has met with unqualified success, now bring it to the attention of mine owners and mine officials through an advertisement in The Colliery Engineer and Metal Miner.

Fig. 1 illustrates the Bader helmet as improved and perfected by Mr. Willis C. Vajen. It consists of a well-formed helmet, which is placed over the head and face, constructed of a special asbestos tanned leather, or asbestos cloth, rendering it proof against fire, heat, steam, boiling water, and all poisonous pervading aeriform fluids; the helmet sets down close upon the shoulders and is held firmly by two straps under the arms. The occupant is supplied with fresh air from a scientifically constructed metal reservoir located at the back of the helmet, with a capacity of 100 pounds pressure of compressed air, always rendered pure by a certain material used for the purpose. The amount of air in store can always be seen upon the gauge attached to the reservoir, which is easily charged by a special air pump in less than fifteen seconds, and retains the same pressure of pure air for months; it is always ready for service. A lever operated on top of the reservoir forces the air through the supply tubes to a point inside, directly in front of the nostrils and mouth, and in sufficient quantity to render the occupant perfectly comfortable for one hour or longer, as desired for the purpose intended. The fresh air being constantly forced into the inside, creates an outward pressure, and the foul air escapes through the neck gear and around the bottom of the helmet, which is lined with lamb's wool under the lower edge. The two lookouts are constructed of clear mica and protected by four cross-wires. The side or ear plates are constructed with a special diaphragm, so as to render the hearing perfectly distinct. One can plainly hear "the clock tick," and "the pin drop," furnishing all the advantages of one on the outside. The horn, located below and in front of

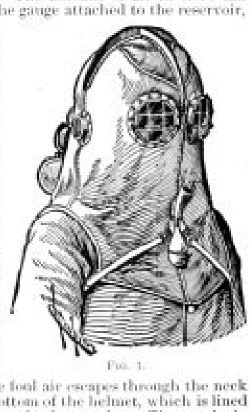


Fig. 1.

the helmet, is used for a call, and is convenient to signal at any time when desired. The Bader Smoke Protector furnishes full protection for the head from falling debris, is graceful in appearance and easily adjusted. The helmet weighs five pounds, is quite ornamental, offering perfect ease and comfort to the wearer and safety from the evil results of smoke, gases and chemicals, all of which must be penetrated to render the vision clear.

The eyesight and the breathing are fully protected by this invention. The nose and mouth are perfectly free, having no connections, affording perfect respiration, without incumbrance of any kind.

Mine owners and mine managers can readily see the advantage of having so effective a device at the mines, whereby they may protect their property and possibly save the lives of endangered employes.

A New Recording Thermometer for Atmospheric Ranges of Temperature.

The novel and especially valuable feature of the recording thermometer herein described is that the recording portion may be located at a distance of twenty-five or thirty feet from the point at which the temperature is to be measured.

This makes it possible to obtain a continuous record of the outside temperature while the recorder is located at a convenient point within doors where it may be readily observed and its mechanism is not exposed to the detrimental influences of inclement weather.

For cold storage plants where closed rooms are to be maintained at a constant temperature for the preservation of meats, fruits and vegetables, an instrument of this kind is of great value, as the temperature may be observed without opening the doors.

FIG. 1.

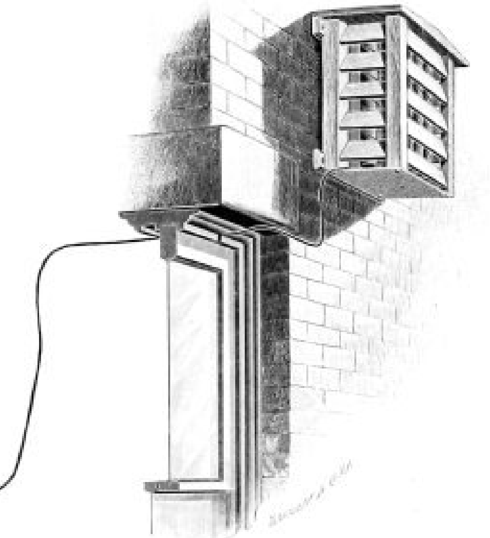


FIG. 2

The recording part (Fig. 1) is an application of one of Bristol's recording pressure gauges. Fig. 3 shows an interior view of the recorder, which consists of a pen arm directly attached to the free end of a tube of flattened cross-section bent into helical form.

FIG. 3.

The bulb portion (Fig. 2) is placed at the point where temperature is to be measured. It consists of a series of helical tubes constructed on the same principle as that in the recorder. The helical coils are suspended in a vertical position with their lower ends free, the upper ends opening into the capillary tube connecting them with the recorder.

The system of helical tubes forming the bulb portion, the pressure tube of the recorder and the capillary connecting tube are completely filled with alcohol under pressure and permanently sealed. As the temperature rises and falls where the bulb is located, there is a corresponding expansion or contraction of the alcohol which is communicated to the recorder and registered on a seven-day chart graduated to read in degrees Fahr.

Excessive pressures due to increased volume of the non-compressible liquid are provided against by the expansible form of the system of helical tubes of which the bulb is constructed.

The total volume of the bulb portion is very large as compared with that of the tube in the pressure recorder, thus avoiding the necessity of compensating for ordinary changes of temperature in the room where the recorder is located.

No correction is required for barometric changes, as only high ranges of pressure are employed.

This thermometer is being manufactured and placed on the market by The Bristol Co., of Waterbury, Conn. At 121 Liberty street, the New York branch of the company, one of the instruments may be seen in operation recording the outside temperature. The recorder is placed in the show window where it may be observed from the sidewalk.

THE BY-PRODUCTS OF COKE.

Their Value and the Importance of Saving and Utilizing Them.

The following extracts, of interest to every producer of a coking coal, are from statements made before the committee on manufactures of the Massachusetts Legislature by Messrs. Henry M. Whitney and Joseph D. Weeks, on March 3rd and 4th, and published in full as a supplement to *The American Manufacturer*, of which Mr. Weeks is editor:—

There is one product of these by-product coke retorts which is exceedingly valuable to our agricultural industries, and I will take the liberty, Mr. Chairman, of reading here from Mr. Fulton's book an extract of what he says is a valuable paper by Dr. Bruno Terne, which was read before the chemical section of the Franklin Institute in Philadelphia, Pa., Oct. 20th, 1891:—

"The consumption of ammonia in its various forms has grown enormously in the last 20 years, and the manufacture of illuminating gas is not longer sufficient to supply the increasing demand for ammoniacal liquors. On the other hand, the inroad which electrical plants for illumination have been making yearly on the production of illuminating gas has already been felt, and will be more so from year to year. The production of water gas and oil gas are other factors that are cutting down the amount of ammoniacal liquors produced.

"But there is another source for tar and ammonia which, so far as my knowledge goes, has, with a single exception, not been worked in our country.

"Rich as are our resources, we are not rich enough to waste continually. It seems strange, and, nevertheless, it is a fact, with all the ingenuity of the American people in the advancement of the purely mechanical part of the technical industries, we have been and are yet slow in the development of the chemical industries.

"The acid manufacturer of Europe, especially of England and Germany, had commenced in the beginning of this century to make himself independent of the sulphur mines of Sicily by using the sulphurous ores of his immediate neighborhood, and to utilize the pyrites for making his sulphuric acid. It has only been within the last 20 years that our people have commenced to use the ores that have been lying under their feet, and to-day, even, the United States consumes more sulphur for the manufacture of sulphuric acid than any other nation.

"It is the same with productions of tar and ammonia as a by-product of the manufacture of coke.

"If you will visit the coal regions to-day you will find the nightly sky illuminated from the fires of the coke ovens, and every one of the brilliant fires bears testimony that we are wasting the richness of our land in order to pay the wiser European coke manufacturer, who saves his ammonia and sends it to us in the form of sulphate of ammonia, and who also saves his tar, which, after passing through the complex processes of modern organic chemistry, reaches our shores in the form of aniline dyes, saccharin, nitro-benzol, etc."

Let me, before I enter upon the subject of gas, refer to the importance of ammonia. Everybody who is familiar with agriculture knows that the three essential elements of plant food are nitrogen, phosphoric acid and potash. Now, we have, fortunately for this State, an agricultural experiment station at Amherst, which keeps in close touch with the value of commercial fertilizers, of which the land of this State and of New England is in such great need. A few days ago I visited Amherst and spent an evening with Prof. Groessmann, who has charge of this station. I felt certain that while the theoretical value of barnyard manures was a certain quantity, yet that there was a certain amount of waste from the time that it was dropped until it reached the field, and I was anxious to find what proportion of the theoretical whole was preserved. I found that the experiment station had made tests (66 I think in all) of manures in various parts of this State to determine exactly what the manurial value in nitrogen, potash and phosphorus was as it is put upon the ground. These are Prof. Groessmann's conclusions:

Nitrogen, 4-10 of 1 per cent. equals 8 lbs. at 12c. per lb.; total value	.96
Phosphoric acid, 2-10 of 1 per cent. or 4 lbs. at 5c. per lb.; total value	.20
Potash, 3-10 of 1 per cent. or 6 lbs. at 4½c. per lb.; total value	.27
Total value of one ton of manure	$1.43

Therefore, if you were to buy commercial fertilizers containing the same amount of plant food that is found in a ton of manure, you would pay for it $1.43. I do not undertake to say, Mr. Chairman and Gentlemen, that there are not some other elements in the manure that are of value to the soil, but I do undertake to say that, so far as the experiments of the agricultural station made with exceeding care have gone, you can purchase with $1.43 the same amount of nitrogen and potash and phosphoric acid as you will find in a ton of manure. Very well. Now, then, how many tons of manure do you get from an animal a year? Prof. Groessman says that it is fair to assume that an animal will eat 25 pounds of food a day, and that amounts in round numbers, to 9,000 pounds a year. You can reckon the excrements at about half of the food, or two tons and a quarter. That is, the manurial value of an animal for one year is two and a quarter times $1.43, and that is $3.22.

The professor tells me that, in order to produce good crops, there should be the equivalent of four or five tons of manure, or, better still, six tons to every acre. The importance of this matter to which I am calling your attention is this, that in every ton of bituminous coal burned to-day there is the equivalent of 25 pounds of ammonia, which is the equivalent of five pounds of nitrogen, and, at the same value at which it is reckoned here as manure, there is a money value of 60 cents. The waste of fertilizer in every six tons of bituminous coal which is burned throughout New England, is equivalent to the manurial value of an animal for a year. Now, what does it mean with reference to the agricultural industry of Massachusetts, if all this nitrogen could be saved and placed upon your soil? It means that in this 6,000,000 tons of coal that are burned throughout New England to-day there is a manurial value of a million of cattle. I know of nothing more hopeful for the agriculture of this State, nor of New England, nor of the whole of this broad land, than that capitalists are turning their attention to-day to the preservation of this great amount of nitrogen which is needed for your exhausted soils. What does it mean? Am I mistaken in thinking that this is an enterprise which this State can properly encourage? It means, of course that throwing such a large amount of nitrogen upon the market will cheapen its cost, and that is the advantage of it. I should welcome the time for New England when nitrogen would sell for a quarter of its cost to-day. From 1882 to 1894, 12 years, sulphate of ammonia ranged in price from $90 a ton. The lowest price was about $60. Today, I am happy to say, it is selling for $60 a ton to farmers, and the people in Johnstown told me that they were receiving $52 a ton. Mr. Chairman and Gentlemen, every man who is familiar with the necessities of agriculture at this day, and understands what the cheapening of nitrogen means, understands what a great benefit the saving of these by-products will be to these people. Prof. Groessmann told me that, in his judgment, the problem of the times was how to increase the supply of nitrogen, and anybody who had any scheme calculated to increase and cheapen it was doing a public service.

Mr. Jos. D. Weeks of Pittsburg, Pa., stated, in answer to questions by counsel, that he was editor of the *American Manufacturer and Iron World*, of Pittsburg, Pa.; that he had been interested in the study of coke and coking for twenty-four years, having published in that time quite a number of monographs on this subject; that he had had charge at both the Tenth and Eleventh Censuses, (1880 and 1890), of the United States of the reports on coke, petroleum and natural gas; that he had been for 12 years expert of the United States Geological Survey on these subjects, and as such had visited England, Belgium, Germany and France in 1894 and 1895, charged to examine and report upon coking in by-product coke-ovens; that he had seen at least 2,000 of these coke ovens in operation; that he had been secretary of the board of judges, department of mines, mining and metallurgy at the World's Columbian Exposition, and that he had just completed a term as president of the American Institute of Mining Engineers.

Mr. McLaughlin of counsel, having asked Mr. Weeks to state what was meant by coke, how it was made and how it differed from anthracite and bituminous coal, as well as any other facts and information material to the question at issue, replied:

Mr. Chairman and Gentlemen of the Committee: I think it best for a clearer understanding of this question that certain facts regarding coal, as well as the differences between varieties of coke should be stated. Without entering into a discussion of all the varieties of coal, it is sufficient for my purpose to state that there are two kinds of coal, anthracite and bituminous, or, as they are commonly named, hard coal and soft coal. The differences in these coals are chiefly two:

First.—In the amount of volatile matter contained in them, that is, the amount or percentage of volatile substances that can be driven off from these coals by heat, and

Second.—Differences in physical structure.

Anthracite coal contains from 5 per cent. to 10 per cent. of volatile matter; bituminous coking coal, 15 per cent. to 36 per cent., while coke, which is made from bituminous coal by processes that I will describe later, contains from one-half to 1 per cent. The other constituents of all of these fuels are carbon and ash. Analyses of each of these coals and coke are as follows:

ANALYSES OF ANTHRACITE AND BITUMINOUS COAL AND COKE.

	Anthracite.		Bituminous.	Coking.	Coke.	
	I.	II.	I.	II.	I.	II.
Volatile matter (including water)	5.582	11.100	32.60	21.970	0.490	1.104
Fixed Carbon	83.672	78.891	60.92	73.728	89.556	92.590
Ash	10.746	10.009	6.48	4.672	9.954	6.306
	100.000	100.000	100.000	100.000	100.000	100.000

These coals, that is, the anthracite and bituminous, though they differ now greatly in chemical constitution and physical structure, were originally the same. Pittsburg gas coal, Connellsville coking coal, Cumberland "Big Vein" steam coal and certain Pennsylvania anthracites are all the Pittsburg bed of the upper coal measures. Here, for example, is a piece of anthracite coal, here is a piece of bituminous coal and here is a piece of coke made from Pittsburg bituminous gas coal in a by-product oven (showing the samples to the committee). These coals as well as this coke were at one time in their history the same. The anthracite was at one time a bituminous coal. The volatile matter contained in them has been driven out of it by the earth forces and heat, by the pressure of the earth's strata above it, and by the heat of the earth that has been generated possibly by the earth movements that threw up the Appalachian mountains. In this respect the only difference as compared with bituminous coal between an anthracite coal and coke is that in the anthracite coal the volatile matter has been driven off by natural causes while in the coke the volatile matter has been driven off in ovens in an artificial manner by heat.

Now which of these fuels is the best? Practically a solid fuel with more carbon and less volatile matter is a better fuel than one that has less carbon and more volatile matter. So that pound for pound anthracite is a better fuel than bituminous coal, and coke better than anthracite, as bituminous coals contain say but 61 to 73½ per cent. of carbon, anthracite 78½ to 83¾ per cent., and coke 89½ to 92½. The coke is the better.

You will notice, Mr. Chairman, from an inspection of these samples that the anthracite is perfectly solid while the coke is porous, it is filled with little cells. It is this porosity, this cell space, that makes coke a more vigorous fuel than anthracite, that is, it will burn more rapidly, just the same as a pound of shavings will burn more rapidly than a pound of solid wood. There is the same amount of heat in the same weight of each, but the one burns much more freely, much more rapidly, is a much more vigorous fuel.

It is this porosity of coke, combined with its toughness and hardness, that in a large measure gives coke its value as a blast furnace fuel, much superior to anthracite. A modern blast furnace say 18 feet in diameter at the boshes using anthracite coal will do good work if it makes 400 tons a week. A furnace of the same size using coke will make four times this amount, and a furnace is being built at Pittsburg to use coke as fuel that will make at least 500 tons a day, a feat that would be utterly impossible with anthracite as a fuel. In our United States practice the value of a blast furnace fuel depends largely upon the rapidity with which it will do its work. It is the same in many operations. We must do our work quickly, and to do this where heat is used we need a quick acting vigorous fuel. This gives a porous fuel like coke its great value. I could make a fuel in a coke oven very like anthracite, provided I did my coking under pressure; but I would destroy one of the most valuable features of the coke as a fuel, namely, its "porosity."

This porosity must be kept within proper limits. Coking is simply the driving off from bituminous coals, by the action of heat, of the volatile matter they contain. No matter how coking is performed, whether it be in an illuminating gas works, for the manufacture of illuminating gas is from one point of view a coking process, or in a bee hive or a by-product coke oven, what takes place is always the same. As the heat is applied the coal begins to swell, becomes pasty and sticky, and throws off bubbles of gas. In a word the coal melts, loses all traces not only of its original form but of its appearance and structure as well and the particles freed from volatile substances unite in a coherent mass or as it is termed "cake" or "coke." As this melted coal solidifies or "cakes," it encloses small bubbles of gas, which makes the cells like those in this piece of blast furnace coke if the gassing process has not been pushed too rapidly. But these pores, these cells, can be made large or small. If the operation is with a small body of coal and the "gassing" is pushed, you get the weak coke with large cells known as gashouse coke, that will hardly bear its own weight. But if the coking is done under proper conditions, you get a hard, strong coke that will bear the burden of the blast furnace. This piece of coke that I show you will bear the burden of a blast furnace 125 feet high, without crushing.

Liebig some years ago laid down four propositions regarding fertilization. First that in order to preserve the fertility of a soil there must be kept in that soil the elements necessary for plant life; second, every crop takes out a portion of these elements. Part of that taken out is added again from the atmosphere, but a part of it never is restored unless it is put there by human means; third, the fertility of a soil remains unchanged if all of the elements of fertility are restored to it; and fourth, the manurial product of a farm never can restore all the elements of fertility to the soil. That is, it makes no difference how valuable is the barn yard manure produced on a farm it never can restore to the soil all the elements taken out of it, and therefore, fertilizers must be added to maintain its fertility. As shown yesterday by Mr. Whitney, the most important elements necessary to be added to maintain this fertility are nitrogen, phosphorus and potassium, or nitrogen, phosphoric acid and potash. The most valuable as well as the rarest of these is nitrogen. There are three chief sources of nitrogen: Chili nitrates, ammonia, and the manures either of the barn yard or the green manures. The chief source of ammonia, which is the most important of these, is coal, distilled either in the gas house or in coke ovens. By the use of the water gas instead of the coal gas process the amount of ammonia produced in the United States in gas works has been very greatly reduced, because in the water gas process no ammonia is produced. It is only in the illuminating coal gas process that it is produced. Mr. Whitney showed you yesterday that in a ton of barn yard manure there was about four-tenths of 1 per cent. of ammonia, or eight pounds. In a ton of coal, coked in these ovens there are 25 pounds sulphate of ammonia, and all of this is being wasted into the air.

As near as I am able to ascertain the consumption of commercial fertilizers in the United States in 1894 was 1,550,000 tons in which is included some 31,000 tons of ammonia. If the ammonia from all the coal coked in the United States in 1894 was saved it would amount to about 150,000 tons sulphate, and this would yield over 1,000,000 tons mixed fertilizers, containing 3 per cent. of nitrogen. Regarding the probability of an increased consumption a large dealer in fertilizer writes me:

"If the price was lowered the consumption of it would vastly increase. The question then would be, Can they afford to do without it in agriculture? not whether they could afford to use it."

From Mr. Groessman, of the Massachusetts Agricultural Experiment Station, to whom Mr. Whitney referred yesterday, I have this letter:

"The use of ammonium sulphate as a source of nitrogen for plant food is limited merely by its high market cost. Its high agricultural value is not questioned any more; and its consumption, it may be confidently assumed, would increase in the same ratio as its market price will be lowered."

As to gas: What is the relation between the gas produced in these ovens and the gas produced in retorts in the manufacture of illuminating gas? There are three gases used for commercial purposes: first, the illuminating gas made from coal; second, water gas, which is also in part a coal gas made by the well-known water gas processes, and third, a producer gas, that is, a gas that is made by burning all the combustible parts of coal with a mixture of air into gas. This is used in large quantities in rolling mills. Coke-oven gas is practically the same gas as illuminating gas made from coal, and therefore belongs to the first class.

As to the feasibility of enriching coke-oven gas for illuminating purposes at the point of consumption. Look at the analysis of this gas and tell me what in the world is there to prevent enriching it. What obstacle is there to enriching a gas which contains 25 per cent. of marsh gas and 61 per cent. of hydrogen up to almost any point desirable? And it is a great deal better to do it at the point of consumption than at the point of origin, because the difficulties that come from attempting to convey under pressure the illuminants, which are condensable, are avoided. There are many methods of enrichment in a small way that are feasible and not expensive.

I now come to a most important practical question, viz: Can this coke-oven gas be used economically for heat and power? I have shown that in heat units and chemical composition coke-oven gas does not differ materially from illuminating coal gas, so that for all purposes of heat and power it may be assumed that the two gases are the same. There is no purpose for which coal or coke can be used that gas will not serve, except where a burden is to be carried, as in the smelting of iron in the blast furnace and in the melting of iron in the foundry cupola. In these cases the iron must be kept apart and the fuel has to bear a burden and consequently, in a blast furnace or a foundry cupola, gas cannot be used. Do not understand me that gas cannot be used to make wrought iron from the iron ore or that gas cannot be used to melt pig iron for foundry purposes, because gas can be employed in reducing iron ore, by the direct process, so called and iron is melted for foundry purposes every day by the use of gas in what is known as the air furnace. For all heating purposes in the large mills in Pittsburg, gas is used almost exclusively. Where natural gas is not burned, producer gas, which has not one-third of the heat units per cubic foot which this coke-oven gas has, is used very largely.

VENTILATION OF FIERY MINES.

A Discussion and Criticism of the Separate Ventilation Theory.

Mr. J. J. Mayer, a prominent Austrian mining engineer, very intelligently discusses the separate ventilation theory for fiery mines, in a recent Austrian government publication. Our British contemporary, *The Colliery Guardian*, publishes a translation of his article, and we herewith publish it, with the metrical measurements given in their equivalents in American terms:—

The object of separate ventilation—by which term is understood the independent ventilation of preliminary headings and workings lying out of the direct line of the main air supply—is to reduce the depression of the main current, *i. e.*, to lower the resistance, which the diversion of the main current into all the branch workings by means of valves and splittings would tend to increase. It is therefore intended to assist and supply the deficiencies of a main ventilator, which, by reason of the extension of the workings, the insufficient diameter of the ways, or from other causes producing high resistance, is incapable of supplying the whole of the air needed throughout the pit, and where, from motives of economy, it is not expedient to replace the installation by a more powerful one. This is the sole *raison d'être* of the separate system, and the extension lately advocated and partly carried out in the Saarbruck district cannot be looked on as justifiable.

If the only point to be considered were the supply of a certain quantity of air to the workings in a given time, then it would be immaterial how this air were introduced—whether by the aid of compressed air, hydraulic pressure, ventilating fan, etc.—but it is found that the composition of the air employed is a far more important factor than mere quantity. For instance, air taken from a current already fouled with gas cannot serve as a means of purifying to the fullest extent the workings into which it is diverted or forced; and in fact, attempts made in this direction failed, even when the draught was so strong as to interfere with the working, simply because the air used was impure, the small amount of pure air derived from the motive power working the fan being insufficient to work any beneficial effect. Of course, where the fans are worked by hydraulic pressure the results will be even more unfavorable.

Objection has of late been taken by Uthemann to ventilation by parallels, on account of the great expense of constructing and maintaining the double workings, the liability of the cross-drivings to harbor fire-damp, and the increased quantity of gas bleeding from the larger surface of coal exposed by this method, and he has advocated the abolition of this system in working seams, proposing in substitution the adoption of single headings ventilated separately. This plan is pursued in the Reden and Konig pit at Saarbruck, and it is asserted that the alteration resulted in a saving of wages alone amounting to some $7,300 in one year. The ventilators used are small, not exceeding 4.1 ft. in size, and are therefore got into the pit without difficulty. The latest compressed air fan used at Reden is of the Ser model with arms 20″ in diameter, and driven by belting. These ventilators have also been used with hydraulic power, worked by a Pelton wheel giving 1,700 revolutions per minute, the fans themselves having a speed of from 600 to 1,000 turns per minute. The air supply is conducted through plain cylindrical troughs of galvanized iron, 11.8″ to 19.7″ in diameter, which are found to act better than corrugated pipes and deliver double the quantity of air under identical conditions. The troughs are connected by socket, or more frequently with flange joints, and the percentage of waste air is 25 per cent. in lengths of 328 ft., 50 per cent. in 656 ft., and 76 per cent. in 1,640 feet, the actual figures obtained from a 11.8 trough supplied by a Pinette fan being as follows:—

Length of trough. Feet.	Revolutions of fan.	Effluent air per minute. Cubic feet.	Loss per cent.
328	798	1,118.4	27
	1,063	1,398.9	25
656	762	737	50.5
	950	927.7	50
1,315	698	362	74.5
	928	441.4	74.5
1,672	685	347.5	75
	907	407.9	77

At present there are eighteen fans working by compressed air, supplying twenty-three workings at the Reden pit, and at the Konig pit fourteen worked by hydraulic power, together with twelve by running water, and supplying thirty workings.

So far as the reduction of the working expenses is concerned this system answers its purpose, but when the question of safety is approached matters wear a different aspect, for if it be considered that in ordinary workings strong brattices and bricked airways are always erected as a precautionary measure for obviating the risk of the interruption of ventilation in case of an explosion, and that only where the drivings are short are metal troughs used, what can be the security of the miners working in headings of considerable length when the only air supply is conveyed by these slender troughs which a slight shock would be sufficient to split, and thus render useless, especially in view of the great danger existing in headings driven along seams? As a matter of fact, their position is a very critical one, and the prospects of rescuing any who may be in the workings at the occurrence of even a local explosion of gas would be extremely remote, if not impossible, the only means of communication being through the single way, some 100 yards in length, in which a fall might easily occur. Uthemann puts forth another argument in favor of the single heading system, viz., that an explosion will be more localized, as the gases will remain *in situ*, but this means that the men actually on the spot will certainly lose their lives that the others may escape, an axiom that is surely not justifiable. Besides, the localization of an explosion—say in the case of coal dust, as shown by the experiments of the English committee—is improbable, but the danger remains that the men in other workings may have no way of escape, while with parallels there is always a better chance for them, apart from the additional security afforded by the more substantial separation of the airway right up to the working face.

In the Karwin district, where separate ventilation is employed, the Steindel (exhaust) compressed air system is more generally adopted, as being safer than the fragile fans, the breaking of one of which would leave a whole section of a pit without an adequate supply of air. In a ventilating test made at the Heinrich shaft of the k. k. priv. Kaiser-Ferdinands-Nordbahn, a Capell fan, driven at a speed of 1,100 turns per minute, supplied the necessary air to a 1,821 ft. length of troughing, but at this high speed the wearing parts of the machinery were soon worn out, and it was found expedient to resort to the compressed air exhaust with 0.12″ jet, since the cost of maintenance was thereby reduced 20 per cent., although a much greater quantity of air was used up. As safety is the chief consideration in fiery workings, the exhaust method is preferable to any other method of separate ventilation; but the very best plan is to ventilate direct from the main current, keeping, of course, a sufficient amount of reserve power for emergencies and developments.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING METHODS.

The Resistance Due to Air—The Different Velocities of Falling Bodies—The Effects of Different Suspension Surfaces—The Unit for the Velocity of Dust Particles—What Should be the Limiting Sizes of Dust Particles—Recapitulation of Facts and Principles.

94. **The Resistance Due to Air.**—All bodies are subject to resistance during their passage through air, and by observing the conditions of surface extension and mass that affect it, we are soon able to classify its modes, and determine the amounts of retardation that are peculiar to each of its phases. As for example, we can throw a pound weight of lead much further than a pound of wood, or a pound of cork, because the matter in the wood has a greater surface of suspension than that of the lead, and presents to the fluid through which it passes a larger area of end surface in the ratio of 5 to 1. From this, then, we see that the distance a body will travel in air is not only a question of velocity but also one of density. Again, a cylinder of wood moving endways through air, is subject to less resistance than a cube or sphere of the same substance, and the same is true of masses of any other kind of matter, and to illustrate this fact Fig. 134 is introduced. For example, at *C* we have the muzzle of an old-fashioned smooth bore cannon for throwing spherical shot, as *B*. Now, if the shot *B* contains the same mass in the same volume as *A*, we can see that the cylinder will meet with less resistance from the air than the sphere, because the extension of the surface of the cylinder across the line of its motion will be much less than that of the sphere, for let us observe that the transverse section of the cylinder, being less than that of the sphere, the displacement at the front of *A*, as *f*, and the closing in at the rear, as *r*, will result in a smaller volume of exchange than at *f* and *r* in the front and rear of *B*; on the principle that a sheet, one yard square, that is extended or spread out in a plane at a right angle with the line of its motion, will push from its front side as great a volume of air as a cube, all of the sides of which are one square yard in area, and the vacuum in the rear of the sheet will be as complete as it would be on the rear side of a cube. The object of the rifled gun *G* is to give a twirling or rotary motion to the shot around its long axis, on the principle of a rotating top that continues to revolve persistently in the same plane; in the same way the shot is made to keep the plane of its axial rotation at a right angle with the line in which it moves *en masse;* that is to say, the long axis of *A* after leaving the gun, continues to move along its path or trajectory *t t* until its journey ends, with its ends *f* and *r* in front and rear; and the result is the shot, continuing to move end on, is subject to much less resistance from the air than the sphere, and this is illustrated in the figure. A shot may be thrown at the highest velocity attainable with the most powerful gun in use, but whether the shot be large or small, swift or slow, the moment it emerges from the muzzle of the gun it begins to fall, and that, too, at the ordinary rate of 16 feet the first second, and 64 feet in two seconds, and so on, and it is on this account that we know that the sphere suffers a greater resistance, because if *G* and *C* are fired at the same elevation, *B* reaches the ground long before *A*, and this is indicated by the curvature of the trajectory of *B*. By the direction of the arrows in front of the sphere the shot is seen to push the air out of its course, and by the direction of the arrows in the rear, the air is seen to rush into a partial vacuum.

95. **The Different Velocities of Falling Bodies.**—Fig. 135 is introduced to illustrate how the velocities of falling bodies are affected by their densities and the transverse extension of their surfaces. First, then, we have three cubes of coal, *C*, *c* and *s*, and a cube and a cylinder of wood, *W* and *w*; a sphere of lead *L*, and a long and a short cylinder of iron, *I* and *i*. Now, if all

FIG. 134.

these masses are let fall down a vertical mine shaft at the same moment of time, they will soon be found to be moving with different velocities, as for example, the little cube of coal *s* will present, for its weight, a greater suspension surface to the resisting fluid than the cube *c*, and the latter will present a greater suspension surface, for its weight, than the cube *C*, with the result that the velocities of the cubes in falling, will be in the inverse order of the square roots of the ratios of their suspension surfaces, as will be more clearly shown further on. Again, if the suspension surface of the cylinder of wood *w*, be taken as the area of one end, and if there is as much weight of wood in *w* as in *W*, then the cylinder will fall quicker than the cube, and this is graphically shown at *C' c' s' W'* and *w'*. The sphere of lead, although it is a sphere, will fall quickly, because its suspension surface is small in relation to its weight, and we can therefore see that a cylinder of lead might be made to fall with an accelerating velocity, nearly equal to a body falling in a vacuum. The next is an interesting example, for here we have two cylinders of iron *I* and *i*. Now the actual end surface of *i* is the same as that of *I*, and yet as far as the quantity of matter in the two bodies is concerned, the *suspension* surface of *i* is greater than that of *I*, and the result is *I* soon attains a higher velocity in falling than *i*. All this will be still more clear after we explain what is meant by the suspension surface with the help of Fig. 136.

96. **The Effects of Different Suspension Surfaces.**—Here *C* is a large cube of coal that we may consider to be a cubic foot or cubic inch, just as may be required for explanation, and to sustain what we are aiming at, namely, to find what coal dust really is, let us watch the conduct of this cube of coal falling down a mine shaft, and let us first consider it a cubic foot, and second, a cubic inch. It is clear that when the resistance of the

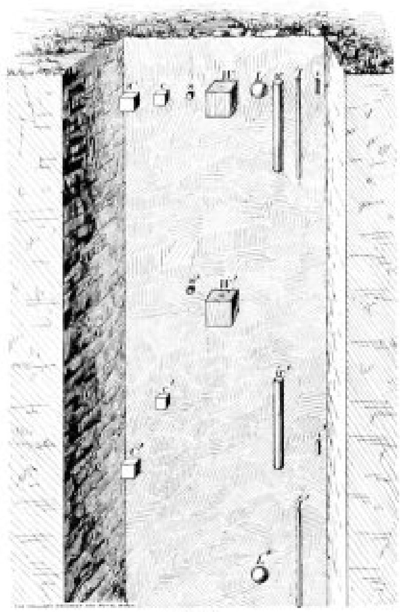


FIG. 135.

air in pounds per square foot is equal to the weight of the cubic foot of coal, the falling cube will cease to accelerate its velocity. Let us, then, take the cubic foot of coal to weigh 80 pounds, the pressure of the atmosphere in pounds per square foot at 2,120, and the *square* of the velocity of air rushing into a vacuum at 1,800,000, then it follows that $\sqrt{\frac{1{,}800{,}000 \times 80}{2{,}120}} = 260.623$, equal to the velocity in feet per second at which the falling cubic foot of coal will cease to accelerate. Next let us try to obtain some idea of what is meant by the surface of suspension, and to make that clear, let our cube of coal this time be a cubic inch, instead of a cubic foot; then a cubic inch will weigh $\frac{1 \times 80}{1{,}728} = .046296$ of a pound. Again, the face of one of the sides of the cube is one square inch instead of one square foot, or 144 square inches; and the pressure at which acceleration will cease must be reckoned per square inch, as $\frac{2{,}120}{144} = 14.72$ pounds,

$$\text{or, } \sqrt{\frac{1{,}800{,}000 \times \frac{80}{1{,}728}}{\frac{2{,}120}{144}}} = \sqrt{\frac{1{,}800{,}000 \times .046296}{14.72}} = 75.24,$$

the velocity in feet per second at which a cubic inch of coal will cease to accelerate in falling through air. Now the cubic foot ceased to accelerate at 260.623 feet per second, and the cubic inch of the same mineral ceased to accelerate its velocity at 75.24 feet per second, and therefore, we observe that $\frac{260.623}{75.24} = 3.33$, that is, the velocity of a cubic foot of coal is 3.33 times greater than that of a cubic inch, when it ceases to accelerate; and further, for the same mineral, these velocities vary as the fourth roots of the surfaces of suspension, as $\sqrt[4]{\frac{144}{1}} = 3.33$ as before. Referring to the last figure, again observe the

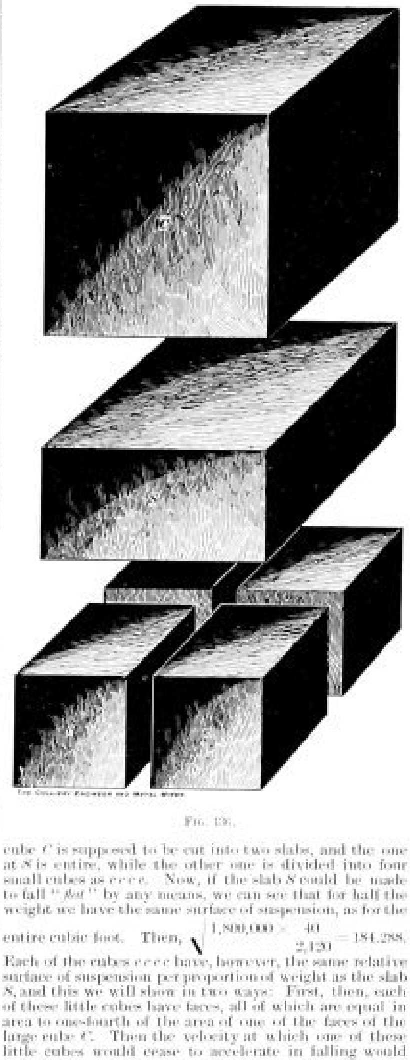


FIG. 136.

cube *C* is supposed to be cut into two slabs, and the one at *S* is entire, while the other one is divided into four small cubes as *c c c c*. Now, if the slab *S* could be made to fall "*flat*" by any means, we can see that for half the weight we have the same surface of suspension, as for the entire cubic foot. Then, $\sqrt{\frac{1{,}800{,}000 \times 40}{2{,}120}} = 184.288$. Each of the cubes *c c c c* have, however, the same relative surface of suspension per proportion of weight as the slab *S*, and this we will show in two ways: First, then, each of these little cubes have faces, all of which are equal in area to one-fourth of the area of one of the faces of the large cube *C*. Then the velocity at which one of these little cubes would cease to accelerate in falling would be $\sqrt[4]{\frac{1}{4}} \times 260.623 = 183.86$ feet per second.

97. **The Unit for the Velocity of Dust Particles.**—From what has been done, we have made good progress in finding out that the velocities at which falling bodies cease to accelerate vary as the fourth root of the areas of their surfaces of suspension. We found that a cubic inch of coal ceased to accelerate when its velocity in falling was equal to 75.24 feet per second; now at *A*, Fig. 137, a cubic inch has first been split into four slabs, and each of these slabs has been cut up again into 16 little cubes, or to put the matter very plainly, a cubic inch has been cut up into 64 little cubes. Now if a cubic inch has a limiting velocity of 75.24, one of these little cubes whose length, breadth, and depth are each one quarter inch will have a limiting velocity of $\sqrt[4]{\frac{1}{16}} \times 75.24 = 37.62$. That is, a piece of coal the $\frac{1}{64}$th of a cubic inch would cease to accelerate in falling when the velocity was 37.62 feet per second, or in other words, 37.62 feet per second is the limiting velocity of these small cubes. Again at *C*, a cubic inch of coal is divided into 13 cakes or slabs and the cake is seen to be divided into 13 × 13 = 169 little cubes, or the cubic inch is divided into 2,197 cubes. Then the limiting velocity will be $\sqrt[4]{\frac{1}{169}} \times 75.24 = 20.86$ feet per second. The cube at *C* is intended to explain what we mean by slabs or cakes, and the numbers are indices of fractional divisions.

98. **What Should be the Limiting Sizes of Dust Particles.**—This brings us immediately face to face with the aim and intention of this lesson, and now let us ask ourselves what dust is, and I think I hear all our readers respond, by dust we mean a cloud of particles that are raised by a wind, whose velocity is greater than

the limiting velocity of these particles when falling; and we know this to be true, because *some* of the particles continue in suspension long after the breeze has subsided. Good! Good!! But you said *some* of the particles, and I suppose you mean the smallest, and this suggests that the particles of different sizes and different specific gravities fall through a height of, say, 10 feet in different times; just so, you reply; and you are correct in your conclusion, say we; and all this having been admitted, we are forced to the conclusion that the particles might be classified by their limiting velocities; for we have seen that the moment the velocity of the wind exceeds the limit of the velocity at which a falling dust grain ceases to accelerate, at that same moment the little body will be raised and join in the company of millions of such particles that go to

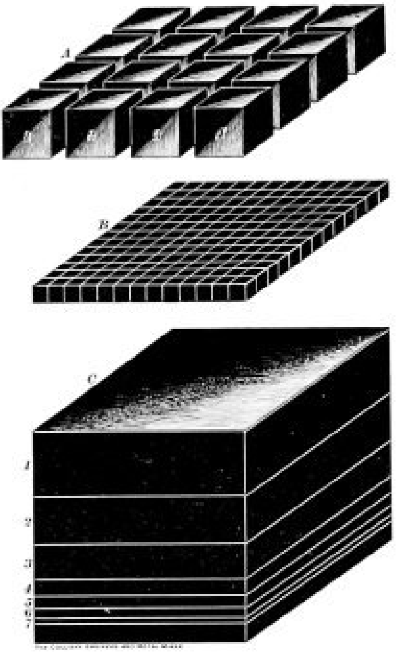


FIG. 137.

make a dust cloud. The subject under investigation, namely, the classification of dust particles, will increase in interest as the manifest importance of the question develops, and therefore, let us recapitulate, with questions and answers, the facts of importance in this lesson, and thus secure a tight hold of the principles to be mastered.

99. Recapitulation of Facts and Principles.—QUES. 1. Does the speed of a body accelerate as much when falling through air, as it does when falling in a vacuum? And if not, why not?

ANS. A body does not accelerate as much in feet per second, when falling through air as it does when falling in a vacuum, because air in common with all matter has weight, and therefore work has to be done in overcoming its inertia in displacing it, and as time is required for the inert air to close in on the rear side of the falling body therefore such a body is subject to a greater resistance on its rear than on its bottom side, and this resistance retards the bodies motion by neutralizing a portion of the earth's attraction. A body falling in a vacuum, is not subject to a greater resistance on its rear than on its front side consequently it is subject to the whole of the earth's attraction, and accelerates at the rate of 32.16 feet per second.

QUES. 2. How does it happen that in calculating the resistance due to a body falling through air, $2g$ instead of g is used, or 64.32, instead of 32.16, for the acceleration in feet per second?

ANS. The constant g, or 32.16, is the equivalent of the earth's acceleration during the period when a body is falling, and to find the energy *stored* in a moving mass, the expression $\frac{v^2 w}{g}$ supplies it, but this is the equivalent of what is called the *vis viva* or the total energy stored in a mass moving with a given velocity.

The *vis viva* is not even the equivalent of pressure, for the moment the moving mass begins to overcome resistance or do work, then the *vis viva* is converted into executive or kinetic energy, having the mean value of $\frac{v^2 w}{2g}$ foot pounds. *Vis viva* is the equivalent of inertia and is therefore more closely allied to momentum than kinetic energy; for example, let a small hammer weigh half a pound, and suppose a man to bring it down on the head of a nail with a velocity of 100 feet per second, and further suppose the nail to advance $\frac{1}{8}$ of an inch with the blow, then the pressure through the distance of an eighth of an inch will be 96 times, that exerted through the space of one foot, or $\frac{100 \times 100 \times .5 \times 96}{64.32} = 7{,}462$ pounds. Or, one blow of the hammer does 7,462 *one-eighth of inch* pounds. We see, then, if work is done through even such a short distance, the *vis viva* energy becomes kinetic.

QUES. 3. What is meant by the "surface of suspension?"

ANS. The surface of suspension is the end surface of a falling body, and the upper surface is the real suspender, because the resistance due to the vacuum over the upper end is much greater than the resistance due to the compression under the bottom end. The extension of the surface of suspension varies for the same weight, inversely as the specific gravity of the substances that fall, and it is greater for spheres and cubes than for bars and cylinders.

QUES. 4. How do you find the velocity at which a falling body will cease to accelerate?

ANS. The velocity at which a falling body will cease to accelerate is the one that will develop a resistance on the surface of suspension equal to the weight of the body that is falling, and the required velocity is found as follows: Let the weight of a cubic foot of coal be 80 pounds, the surface of suspension one square foot, the pressure of atmosphere 2,120 pounds per square foot, and let the square of the velocity of air rushing into a vacuum be 1,800,000, then we find that $\sqrt{\frac{1{,}800{,}000 \times 80}{2{,}120}} = 260.623$ is the velocity at which a cubic foot of coal would cease to accelerate.

QUES. 5. Are the surfaces of suspension in the same proportion to the weights of large and small cubes of the same material, and if not, how do they differ?

ANS. For the same material of any kind, the surfaces of suspension of cubes vary as the cube roots of the contents or inversely as the weights of the cubes. For example, cut up a cubic foot of coal into eight cubes, then the proportion of the surface of suspension to the weight will be for the little cube $\sqrt[3]{8} = 2$; that is, the proportion of the surface of suspension to the weight in the little cube is twice that of the large one.

QUES. 6. Is there any relationship with regard to the limiting velocities of cubes or spheres of different contents or weights?

ANS. Yes; there is such a relationship when the cubes or spheres are of the same material; and that is, the limiting velocities are directly as the cube roots of the weights or contents. For example, the limiting velocity of a cubic inch of coal is 75.24 feet per second, and a little cube of coal has a content equal to the $\frac{1}{425{,}938}$ of a cubic inch; or, the weight of this little cube is $\frac{1}{425{,}938}$ of the weight of a cubic inch of coal; then the limiting velocity of the little cube is $75.24 \times \sqrt[3]{\frac{1}{425{,}938}} = 1$; that is, the limiting velocity is 1 foot per second.

(To be Continued.)

MINING MACHINERY.

The Hydraulic Main or Delivery Pipe of a Pump—The Connection of the Intermittent Flow—Rod and Plunger Pumps—Recapitulation of Facts.

113. The Hydraulic Main or Delivery Pipe of a Pump.—It is possible to fix a larger pump for the discharge of a greater volume of water, and find when it is done, and tried, that its pumping efficiency is not equal to that of the old one. Now it is true that many causes might be assigned for this failure, but in this case, there is only one to be found; for the total steam pressure in the piston is sufficient for a greater output, the intake and discharge valves are in good order, and the waterways through them are quite sufficient to prevent constriction, and stranger still, the modulus of mechanical effect is equal to that of the best pumps in use; but the one cause of failure in pumping efficiency is found to be this, the diameter of the delivery pipe is too small, and therefore, instead of the pump piston making twenty strokes a minute, it is only making ten. The meaning of all this can be understood with the help of Fig. 147. Here a large pump piston is seen at *P*, whose diameter is three times that of the delivery pipe *H*, and in consequence of this disparity in size the velocity of the flow through the delivery pipe is nine times that of the speed of the pump piston, and when we consider the friction due to such a rapid flow and the resistance due to the acceleration out of the pump cylinder into the delivery pipe, we discover the true cause of the small pumping efficiency of the pump under notice.

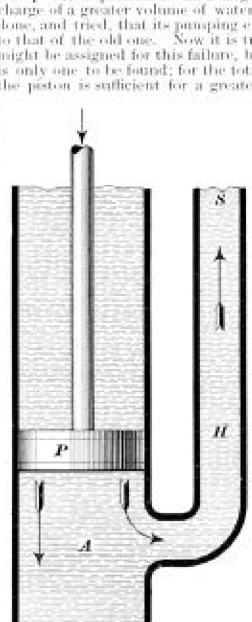


FIG. 147.

For as the steam pressure is constant, and the water head of delivery is constant, and the resistance due to the flow, a variable that increases as the squares of the velocities of flow, it is clear that the variable resistance of the flow will act the part of a regulating governor, restricting the speed of the pump piston to a velocity it can never exceed without an increase in the pressure of the steam. It might be suggested to increase the steam pressure, but to double the pumping efficiency, the total pressure on the steam piston would have to be much increased, and such a mode of proceeding means a large reduction of the modulus, or a small working efficiency of the plant. We see then that the diameter of the pump piston cannot be taken alone to determine the volume of water a pump will lift and discharge in a minute, unless the hydraulic main or delivery pipe is sufficiently large in diameter to run off the flow at a relatively low velocity.

All this, however, is simply a statement that may be on the one hand the writer's *opinion*, but, mere opinions in practical mechanics are not worth the paper they are written on, unless they are the conclusions and deductions from *actual* observations wherein the operations of mechanical law decided the results, for then the statements are based on facts that command respect and attention, and this is the case we claim. There are two factors in the application of steam power that require our closest attention, and these are the *mean effective pressure* throughout the stroke in pounds per square *foot*, and the total volume of the steam in cubic feet per minute after it has expanded; for by the use of these factors the power and also the balance required for the water head plus the resistance due to the flow can be determined. To make this clear let us suppose the mean effective pressure is equal to 30 pounds per square inch, then that would be equal to $144 \times 30 = 4{,}320$ pounds per square foot. Again, let us suppose the volume of expanded steam to be equal to 764 cubic feet, then the horse-power will be equal to $\frac{Q\,P}{33{,}000}$ = the horse-power, or, $\frac{764 \times 4{,}320}{33{,}000} = 100$. Again, $\frac{33{,}000 \times \text{horse-power}}{Q} = P$, and $\frac{33{,}000 \times \text{horse-power}}{P} = Q$.

From these equations we can detect that a steam engine cannot do more work than that due to the volume of steam supplied at a given pressure, and that the boiler cannot generate more steam than that due to the heating surface of the boiler, when the heat supply is normal; further, as the pressure of the steam is stationary, it cannot overcome a resistance greater than that of the balance of the total pressure on the piston. Again, the work done is directly proportionate to the volume of the steam consumed. This being the case, let us carefully notice what follows. First, then, the total steam pressure on the engine piston cannot overcome a resistance that makes the load greater than the pressure, and as the pressure is stationary, so must the resistance remain stationary, for should the latter increase, then the engine would stop, being overpowered by increased resistance. As the resistances due to the movements of fluids vary as the squares of the velocities, then it follows that when the delivery pipe of a pump is too small, a relatively low velocity of the pump piston, by the rapid flow of the column, will develop a resistance, which added to the head, will balance the pressure of the steam on the engine piston; and under these circumstances a small volume of steam will be consumed and a small volume of water will be pumped; for the pump piston could not be run at a much higher speed without a *very great* increase in the pressure of the steam, for in this case to increase the pumping efficiency you must increase not only the volume of disposable steam, but also its pressure. From these facts we learn then that the modulus of a pump, with a delivery pipe of small diameter, may be as high as that of a pump with a delivery column of large diameter; and we must confess that this singular circumstance is misleading, yet we know that the *pumping* efficiency of the pump with the suction and the delivery pipes sufficiently large, is much greater than when they are too small.

114. The Connection of the Intermittent Flow.—When a pump is single and even double-acting, the flow through the column of pipes is always variable in its velocity, and it is claimed that some energy is lost as the result of the force required to set the inert column in motion, but during the period when the stroke is ending, the *vis viva* of the moving water is converted into kinetic energy that assists the pump piston on to the top of its stroke. Apart from this, however, there is a loss due to the acceleration of the column during the stroke, for as the friction varies as the squares of the velocities, it is easy to see that a uniform flow for the discharge of the same volume of water must be subject to a smaller frictional resistance than an intermittent one, and therefore, to secure a uniform flow when the pump piston or pistons are variable in their motion, an air vessel is introduced to equalize, by the elasticity of an air cushion, the pressure of flow; and such an instrument, typical of the forms in use, is seen in vertical section in Fig. 148. To understand its mode of action, we must first consider that, ac-

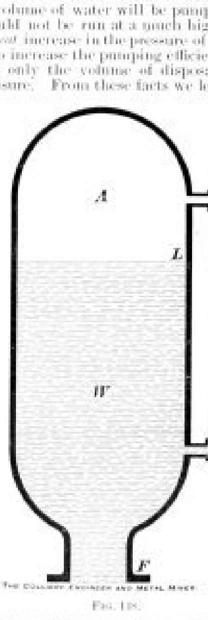


FIG. 148.

cording to Boyle's law, the volume of the air at *A* will be inversely as the pressure; and the result is, if the pump is started with the air vessel empty of water, when the column reaches the elevation of overflow, the air that filled the vessel will be compressed into a small volume; and so much is this the case that if the air vessel was a cylinder of uniform diameter, and the head of column, measured from the level *L*, in the air vessel, to the level of overflow, was 476 feet, then the air would be compressed to the $\frac{1}{15}$th of its former volume, for $\frac{476}{34} = 14$ atmospheres, and as there was in the air at first a pressure equal to 1 atmosphere, $14 + 1 = 15$. Then, suppose the air cylinder to be 8 feet in height, it will now be seen that $\frac{8}{15} = .533$ feet, the depth of air in the cylinder, or it would be equal to $\frac{8 \times 12}{15} = 6.4$ inches. In the figure, *A* is the air space, and *W* is the water space. For two reasons, a useful air vessel is furnished with an air replenisher, and that is a pump to force as much air into the vessel as will make it act as a spring of *long range*, for we must admit that 6 inches is so small that it is not likely to have a cushion range of more than an inch, whereas, if the vessel is half full of compressed air, it may and does attain a range of 8 or 10 inches. Another reason for the use of the replenisher is this: *Compressed air* is soluble to a greater extent in water; than air at atmospheric pressure, and, therefore, when the replenisher pump is not used, the air is soon dissolved out, and then the air vessel is said to become solid. When a replenisher is used, a gauge glass is fixed to one side of the air vessel, as *G T*, and then the level in the gauge at *l* always coincides with the water level *L* within the vessel.

115. Rod and Plunger Pumps.—The rod, plunger and lift pumps are fast passing out of use, and with them, no doubt, will pass away the old Cornish pumping engine. However, they are still in use and the mining engineer cannot therefore disregard them yet. In shallow shafts where great volumes of water had to be lifted, two lift pumps with alternate action were made to do the work, and where the shafts were deep a lifting pump was fixed for the bottom range and then followed in succession the plunger or forcing "sets"; and set in recesses in the shaft side were balance bobs, for relieving the engine of the weight of the heavy wooden rods. What, however, is interesting to us just here, is what is called the H piece *D X Y*, Fig. 149, that is, a single piece of cast iron called the *H* piece, from its resemblance to that letter. The plunger *P*, works through a stuffing box and gland, and is here shown on the up stroke, and the suction water is seen passing up the suction pipe *S*, and on through the suction valve *V*. The *door* at which the suction valve is changed when out of order, for another in order, is seen at *d*. The delivery valve *V*, is seen to be shut, for it only opens during the period of the downstroke of the plunger. At *D* is the door for changing the "check" or "keep" valve. *T* shows the wooden buntons for for supporting the delivery column *H*. In Fig. 150, we have an illustration of what is called the plunger and lift pump. The object of this arrangement is to maintain a continuous flow in the delivery pipe *H*, and to so balance the motor steam engine, and pump rods, that no more work is done on the downstroke than on the upstroke, and this is secured as follows: First then if there were no pump rods to balance, on the upstroke, the displacement of the plunger would be made to be equal to half the water lifted, and therefore on the downstroke, when the pump piston was lifting no water, the plunger would, as shown in the figure, displace the other half of the water lifted on the upstroke, but where the rods have to be balanced the plunger is made larger in diameter, as for example, take the first case and suppose the diameter of the pump piston to be 24 inches; then the diameter of the plunger should be $\sqrt{\frac{24^2}{2}} = 17$ inches, nearly. By this arrangement the piston displaces on the upstroke with an area of 288 circular inches, that is $\frac{24^2}{2} = 288$ and the plunger displaces on the downstroke with an area of 288 circular inches, so that the flow is the same on the up and down strokes. But let us suppose that the displacement of the plunger has to be such that it will balance the pump rods weighing 10 tons, or $10 \times 2{,}240 = 22{,}400$ pounds.

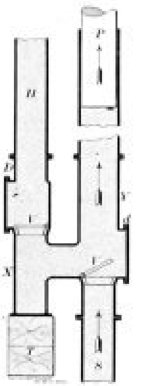


Fig. 149.

The pressure of the head per circular inch will be, when the head is, as in this case, 250 feet; $250 \times .341 = 85.25$ pounds, and therefore the piston or end area of the plunger, to balance the rods, must be equal to $\frac{22{,}400}{85.25} = 262.76$ circular inches. On the down stroke the weight of the rods assists the steam, and on the up stroke the steam has to lift them; the result is, the engine can exert 20 tons more pumping pressure on the down stroke than on the up stroke, and therefore $\frac{2{,}240 \times 20}{85.25} = 525.51$ circular inches must be provided for in piston area for balance alone, and as the area of the pump piston is 576 circular inches, there must be pumped or delivered on the up and down strokes a volume in the proportion of $\frac{(576 - 525.5)}{2} = 25.25$ circular inches. The total area, then, of the end of the plunger must be $525.5 + 25.25 = 550.75$ circular inches, and therefore the diameter of the plunger will be $\sqrt{550.75} = 23.46$ inches.

In pumps of this character, the piston is joined to the plunger with a sword, or toothed joint, *S*, and the two sides of sword are locked securely by the clasp *C*. The door for changing the piston and suction valve is seen at *D*, the plunger is shown at *P*, and the delivery pipe at *H*.

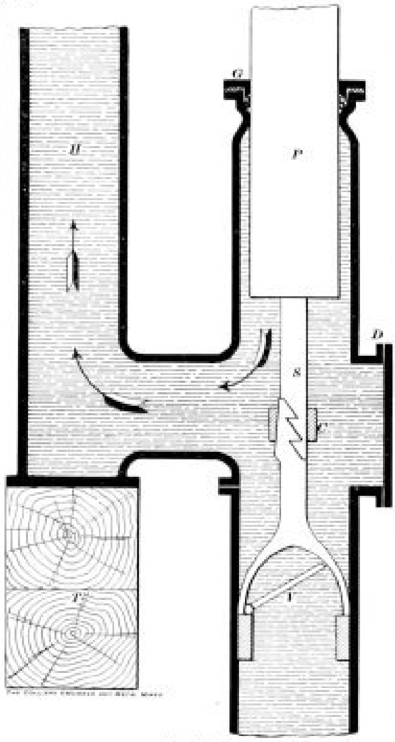


Fig. 150.

116. Recapitulation of Facts.—Ques. 1.—What forces fix the limit of the velocity of a pump piston?

Ans.—There are two forces that control the velocity of the pump piston. The first one is the pressure of the steam, or of any other prime mover; and the second is the resistance of the flow; for after a portion of the pressure balances the water head, the remaining portion can only overcome the resistance of a fixed velocity of flow.

Ques. 2.—How should the diameter of the delivery pipe be proportioned to the diameter of the pump piston?

Ans.—The diameter of the delivery pipe should never be less than the diameter of the pump piston, for if it is so, one of two things must happen. First, the pumping efficiency will be reduced; or, second, the resistance and the pressure of the steam will be very much increased and the pump will have a small modulus of useful work.

Ques. 3.—If the delivery pipe has too small a diameter, and the pressure of the steam is not increased, what will occur?

Ans.—The consumption of steam will be reduced and the pumping efficiency will be reduced in the same proportion as the volume of the steam is reduced.

(To be Continued.)

CHEMISTRY OF MINING.

The Vertical Parallelism or Flames—Forms of Lamp Glasses—The Volume in Relation to the Surfaces of Gauze Cylinders—Commendable Improvements in Lamps—Recapitulation of the Principal Facts.

100. The Vertical Parallelism of Flames.—The flame of a candle or lamp is really a stream of white hot gas, produced by the heat resulting from its own combustion. The gas from fats and oils is generated at the portion of the wick that is situated within the flame, and as the gas escapes from an extended surface, it never attains a velocity into the flame, equal to that of coal gas ejected through a narrow slit in a burner; the result is, the flame of a candle or lamp is always vertical, while the longer axis of the flame from a gas burner may lie nearly horizontal, as the result of the swiftly ejected gas having become ignited before its momentum is expended. The gases that constitute the flame of a lamp, while in a state of incandescence, are much lighter than the cold air in which they float, and the result is, you may cant the candle or lamp, but you cannot cant the flame, and as this is so, it does not require much mental effort to find that the radius of a lamp glass must be so proportioned that the flame can never lick the inside surface of the glass enclosure, for if it is allowed to do so, two things must occur: the glass will be blackened with the sooty smoke of the flame, and as glass is a bad conductor of heat, it will be cracked by the uneven expansion due to the flame heating excessively one point in the shell.

We see then, that when the lamp is held in a truly vertical or normal position the flame is parallel to the axis of the lamp, but if by some accident, ever liable to occur, the lamp should fall on its side, then the flame will be parallel to the vertical radius of the lamp glass, and if the radius of the glass should be too short for the flame, or the flame should be too long for the radius, then the glass would be blackened and cracked even at

Fig. 139.

an angle of inclination of 45° from the vertical, and it is to explain this fact that Fig. 139 is introduced. It will be seen that at *A* the flame fails to reach the glass when the lamp is canted through 45°, and at *B* it just touches, while at *C* both the effects are sure to follow that attention has been drawn to.

101. Forms of Lamp Glasses.—After this we discover that it is no easy matter to determine the form and dimensions of a good lamp glass, and yet we cannot fail to see that little attention has hitherto been given to the matter. Before proceeding further with the investigation let us renotice the principles already treated on. First, then, we found that we should have a maximum length and minimum diameter for the glass, to secure the greatest possible diffusion of light on the roof and floor. Second, a thick glass aided diffusion by increasing the refraction of the light. Third, that a thick glass, or one with an extended surface, offered a greater resistance to the passage of light than a thin glass, or one with a relatively small surface; and now the fourth principle is before us, and it involves the relationship of the radius of the glass to the length of the flame. Now, keeping in view the fact that the glass with the minimum radius secures at once the greatest amount of diffusion, and the least resistance to the passage of light, we should try to find a glass with a minimum top and bottom diameter, and yet to have its sides sufficiently out of the range of the tongue of flame, in the event of the lamp being canted, and to clearly show what is here meant, Fig. 140 is introduced. At *D* a spheroidal glass is shown with the required small top and bottom diameters, and should the lamp from any cause be turned on its side, the tip of the flame *c* during the act of turning would sweep through the arc *c a d*, and when the tip reached *d* it would not touch the inside surface of the glass; had, however, the glass been cylindrical its side would have coincided with the dotted line *e f*, and in that case after the lamp had turned through about 40°, the tongue of the flame would have touched the glass at the point of intersection *a*. At *E* we have a glass that only bulges in the neighborhood of the flame, and it certainly looks more retiring and appears to be more like a befitment for the conditions. Here the tip of the flame would describe the arc *h g l*, and had the glass been a cylinder, its inside surface would have been continued along the dotted

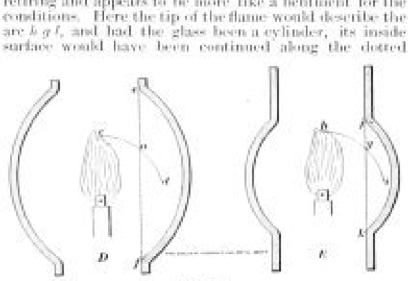


Fig. 140.

line *j k*, and the tip of the flame, after turning through an angle of 40°, would have touched the glass at the point *g*; but it will be seen that in this, as in the other case, the tip of the flame could not touch the glass even if the lamp was turned on its side. These spheroidal glasses look very well in theory, and especially when disassociated with the fact that glasses having large surface areas are great wasters of light; but in practice they would be very disappointing unless some one could guarantee a special make of glass that had a toughness and an elasticity such as no glass was ever known to have before. Glasses of these peculiar shapes are more subject to unequal heating, and consequent unequal expansion, than cylindrical ones. This can be seen by observation and consideration, for let us notice that the spheroidal or belly portion of the glass is cooler under normal conditions than the cylindrical ends, and especially the upper one, through which passes the heated gases from the flame, for here the area is so constricted that the higher temperature causes end expansion, and the frequent rupture of the glass. We see, then, that the safety of the glass shell becomes a matter of serious thought and cannot be overlooked in this investigation.

102. The Volume in Relation to the Surfaces of Gauze Cylinders.—The volume of the gas and air space within a lamp is a matter of serious consideration, for if it is too large, then the oxygen of the entering air is only partially consumed, and, therefore, when the air is charged with marsh gas, and highly heated, the mixture explodes. This has been proved by painful experience, where large Davy lamps have been used. In some cases the writer has seen the gauze of a Davy lamp no less than 3½ inches in diameter and 9 inches in length, and such were the dimensions of the Blantire lamps in Scotland, at the period when the last explosion occurred in that mine. Now, when one of these lamps was placed in a still, or motionless explosive mixture, it fired instantly, and, as we might expect, when a smaller Davy with a gauze $1\frac{1}{2}$ inches in diameter and 6 inches in length was tested under the same conditions, it remained in the mixture from 2 to 3 minutes before it fired, and some Davy lamps withstood the test for a longer time. Let us just compare the two volumes under notice, and to make the matter easy, we will take the relative and not the actual volumes, as

Blantire Davy $= 3.5 \times 3.5 \times 9 = 110.25$.
Improved Davy $= 1.5 \times 1.5 \times 6 = 13.50$.

That is, the contents of the Blantire are 110.25, and those of the improved Davy, 13.5 cylindrical inches, or, the contents of the Blantire gauze were 8 times those of the improved Davy. There are two reasons why the large gauze is dangerous. First, every square inch of gauze is subject to a higher temperature in the large than in the small gauze cylinder, and this can be proved by dividing the contents by the surface of the gauze in each of the two cases, as

$$\text{Blantire} = \frac{3.5 \times 3.5 \times .7854 \times 9}{3.5 \times 3.1416 \times 9} = .875.$$

$$\text{Improved} = \frac{1.5 \times 1.5 \times .7854 \times 6}{1.5 \times 3.1416 \times 6} = .375.$$

We thus see that the heat produced in the large gauze is $2\frac{1}{3}$ times greater per square inch of surface than in the small gauze, for $\frac{.875}{.375} = 2\frac{1}{3}$. Second, in the event of an explosion within the gauze, the flame will not only pass easier through the meshes of the large gauze, but the volume of the flame ejected will be 8 times greater than that of the small one.

103. Commendable Improvements in Lamps.—We cannot but commend real improvements in lamps, and especially departures in the right direction, and here is one of them, that gives a distinctive character to a modified Mueseler lamp, Fig. 141. In it the air to support the combustion of the oil is made to pass down short poles outside of the glass cylinder, and we may rest assured that by this arrangement one good result will be secured, and that is, a better motive column to aid combustion and improve the light. In the old Mueseler, the air to feed the flame first passed through the meshes of the lower end of the gauze cylinder, and then continued on its course through the sheet ring of gauze, called "the diaphragm," and down the glass cylinder to the flame, being impeded all the way with the object of securing the complete isolation of flame. In the Mueseler lamp, however, as in some others, safety was secured by the sacrifice of a good light, and therefore, we admire the improvement here introduced.

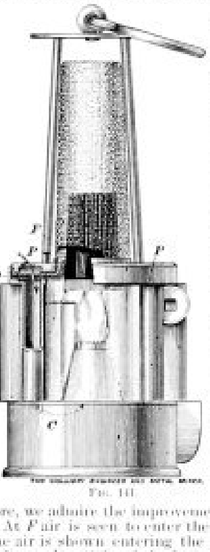


Fig. 141.

At F air is seen to enter the old way, and at P and P the air is shown entering the top ends of the tubular poles, and at C the air is shown leaving the bottom ends of the poles, and, as in the line of the arrow C, we observe it entering a hollow cone, whose top restricts the air stream, and projects it directly onto the flame.

Fig. 142 is a combination of the Gray and the Marsaut lamps, but instead of the air being conducted down the main poles of the lamp frame, a special funnel P is provided, so that when gas testing is required P can be turned up, and a sample of the stratum of air floating under the roof can be conducted right onto the flame. The funnel turns in a vertical plane on the axis H. W is the gauze within the bonnet. O O are ports for the entry of air when the funnel is out of use. This lamp, too, is suggestive of future improvements.

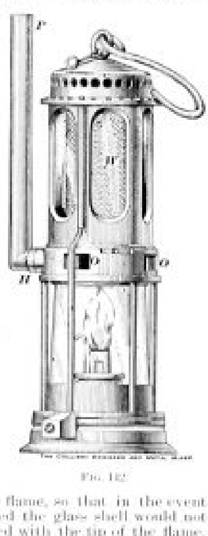


Fig. 142.

All the witnesses on the trial of the lamp glasses are not yet examined, therefore the trial is again postponed.

104. Recapitulation of the Principal Facts.—Ques. 1.—In what way does the flame in a safety lamp affect the length of the radius of the glass shell?

Ans.—As the axis of the flame in a safety lamp is always vertical, the radius of the glass should be longer than the axis of the flame, so that in the event of the lamp being overturned the glass shell would not be cracked by being touched with the tip of the flame.

Ques. 2.—What are the advantages and disadvantages of bulging or spheroidal glasses?

Ans.—The advantages of bulging glasses are that they can be so contracted in their top and bottom diameters as to greatly assist in the diffusion of the light; and their disadvantages are, they reduce the intensity of the light by an over extended surface, and they are liable to crack as the result of their tendency to unequal expansion.

(To be Continued.)

GEOLOGY OF COAL.

The Miner's Interests in Geology—The Origin of Metallic Ores in Veins—The Nature of the Contents of Veins.

60. The Miner's Interests in Geology.—The miner who has push and enterprise in his make-up has a better chance of securing a competency than a man in almost any other profession, for with "Aladdin's" wonderful lamp of knowledge in his hand he can discover the hiding places of nature's boundless treasures.

Not long ago courage and endurance were the prime factors that made successful men, but now such a man requires, in addition to the qualities named, to be learned in the cunning revelations of science, for it is through these that the light shines that dispels the darkness that conceals the rich productions in nature's laboratory. It is strange, and nevertheless true, that notwithstanding the great value and importance of geological knowledge, few men can be persuaded to obtain it. We do not doubt that the cause of the neglect is to be found in the lack of a good, and useful, and interesting literature, especially adapted to the miner's wants, but let him make the best use he can of the supplies of knowledge within his reach and then he cannot fail to reap a handsome reward.

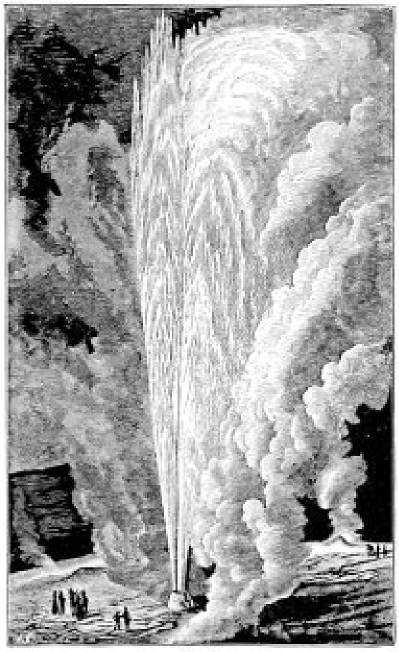


Fig. 98.

61. The Origin of Metallic Ores in Veins.—The science of chemistry, aided by observation, is rapidly removing the veil that concealed the origin of the storage of metallic ores in veins, and in the interstices of certain rocks. We cannot, however, think about the matter even in a cursory way, without coming to the conclusion that the special localization of the ores in veins and in the joints of rocks to which they were peculiar, was not accidental but entirely the result of the operation of forces that may be investigated. The ores, then, have only been deposited where suitable conditions existed for their selection, collection and deposition, and therefore let us here try to find the origin of the conditions under notice; and to assist in the investigation of the matter, let us proceed with the help of Fig. 98. Here we have a natural fountain of boiling water that springs up through a vent whose mouth is surrounded by a hive-like incrustation of silica.

We cannot look at this geyser without feeling a desire to find the answers to some questions its appearance and phenomena suggest, such as: What is the required pressure of the steam that ejects with such force this mighty jet of water? From whence comes the supply of water for the outflow? What kind of chemical and solvent action will boiling water have? What produced the silica hive at the mouth of the vent? And will this incrustation be the result of the same mode of action as the quartz found crystallized on the cheeks of veins?

The pressure of the steam that throws the jet of the geyser to such a great height cannot be measured by the vertical length of this water column, because the resistance of the air, and the expansion of the associated steam, break up the liquid stream into such finely divided particles that the vastly increased surface exposed to atmospheric resistance is enormous, and therefore the height of the jet is far short of that of a solid vertical stream, that would equal the initial pressure of the steam as it was generated in one of the earth's hot rock caldrons, situated far beneath the depths of the deepest stratified rocks. If we claim that the pressure of the steam that tossed up the geyser was considerable, then we must admit that the temperature of the steam at the moment of its production must also have been far higher than any of the sensible temperatures of the steam artificially made, for it is now well known that all temperatures have their corresponding pressures.

If the pressure, and consequently the temperature, of the steam, as generated in the deep hot caverns of the earth, was very great, and we cannot doubt the conclusion, then we can see how silica, lime and the chlorides of the metals and other mineral compounds, have been carried up by the hot solvent waters from the depths of the nether rocks. Again, we can see without an effort of the imagination, that the minerals in solution would crystallize out as they became insoluble through the falling temperature of the water that contained them.

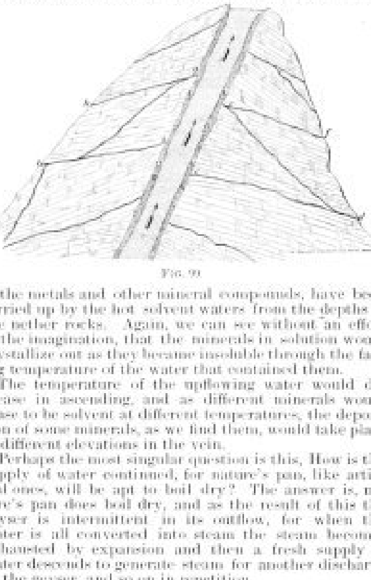


Fig. 99.

The temperature of the upflowing water would decrease in ascending, and as different minerals would cease to be solvent at different temperatures, the deposition of some minerals, as we find them, would take place at different elevations in the vein.

Perhaps the most singular question is this, How is the supply of water continued, for nature's pan, like artificial ones, will be apt to boil dry? The answer is, nature's pan does boil dry, and as the result of this the geyser is intermittent in its outflow, for when the water is all converted into steam the steam becomes exhausted by expansion and then a fresh supply of water descends to generate steam for another discharge of the geyser, and so on in repetition.

We can now see what produced the silica hive-like incrustation around the vent of the geyser, for this is a portion of the silica that was soluble in the very hot waters of the jet, and has become insoluble and crystalized as these waters cooled, and we now learn that the earth's heat has been the principal agent in the selection and deposition of the metallic ores in veins, and to further sustain this conclusion Fig. 99 is introduced.

62. The Nature of the Contents of Veins.—The funnel of a geyser is one thing and the fissure of a vein is another, and therefore we do not expect to find a vein pouring out a great vertical sheet of water, as a geyser throws up a column; but one thing remains common to both, and that is that they alike are channels for the upward passage of hot waters containing mineral matters in solution.

The vein, however, could only be once filled with water, and if a still further upflow continued it would overflow, unless channels were provided for the escape of the excess; and such channels actually exist, for it is the universal experience that the most productive veins are now, or have been at the time of filling, above the drainage level of the region, and the escape or outflow arteries of the containing rocks are such as *h g*, *j i*, *e f*, *c d* and *c d*. The upflow of hot water at the time of the filling of the vein is shown by the arrows, and the crystalization proceeding in the sides of the vein is shown at *a a*, *b b*, etc.

(To be Continued.)

Pipe For Mining Purposes.

The Michigan Pipe Co. of Bay City Mich., the largest manufacturers of Wyckoff (wood shell) pipe in this country, or for that matter, in the world, make their first appearance as advertisers in this issue of THE COLLIERY ENGINEER AND METAL MINER.

The pipe manufactured by this company has had the test of years of service to prove its durability and strength in conducting sulphurous and mineral waters in places where metallic pipe would stand the action of such waters but a few months. Besides water pipe, they make steam pipe casing, bored from solid logs, which is adapted for covering steam pipes in mines and underground work. They furnished the steam pipe casing for the steam heating plant in this city (Scranton), and for all the other steam heating plants built by the American District Steam Company of Lockport, N. Y.

The Michigan Pipe Company has a creosoting plant and manufactures and treats with dead oil of coal tar, conduits for underground electrical wires which are in use in the large cities where wires are buried.

An Injunction Granted.

Judge Dallas, of the United States Circuit Court, filed an opinion on the 6th ult. granting the Ewart Manufacturing Co. a preliminary injunction against James H. Mitchell, restraining the defendant from the manufacture of an infringement of the plaintiff company's patented chain, which is known as the Dodge chain, and which is legally manufactured by the Link-Belt Engineering Co. of Philadelphia and the Link-Belt Machinery Co. of Chicago.

Hose.

The Boston Belting Co., has just issued handsome and convenient little catalogues of superior hose for fire purposes at mines, as well as for municipal fire departments. As a hose for use at coke works, the Boston Belting Co.'s brands stand unsurpassed for durability.

MISCELLANEOUS.

MEXICO'S FLOATING GARDENS.

Tourists who come to Mexico always go to see the floating gardens. But they never see them. The whitest-haired old man now living, if he remembers them at all, recalls them faintly, for this century has seen few of them. Still the floating gardens or "chinampas" in the musical language of the Aztec, are a never-ending attraction to the sightseers, who visit this ancient capital, although, contrary to popular belief, the floating gardens at Santa Anita and Ixtacalco do not float.

Many years since, however, in fact, before the conquest of Mexico by the Spaniards, the name was appropriate, for real floating gardens were then common on the lakes in the valley of Mexico, especially in the immediate vicinity of the city. But when Humboldt visited Mexico (then called New Spain) in 1803, and Abbe Francisco Clavigero, a missionary among the Indians, a few years later, these peculiar possessions of the Mexicans were rapidly diminishing in number, and in 1826, Captain G. F. Lyon informs us that "the little gardens constructed on bushes or wooden rafts no longer exist in the immediate vicinity of Mexico (the city); but I learned that some may yet be seen at Hochimilco." As late as 1888 two or three floating islands still existed in Lake Chalco, and can probably be seen there today. There are no others known now.

Abbe Francisco Clavigero describes the true floating gardens as follows:

"They plait and twist willows and roots of many plants or other materials, together, which are light, but capable of supporting the earth of the garden firmly united. Upon this foundation they lie the light bushes, which float on the lake, and over all, the mud and dirt, which they draw from the bottom of the same lake." The common form was a quadrangle, and the average size about 12 by 40 feet, although some of the largest were 100 feet in extent. Many of the latter contained a small hut, in which the cultivator sometimes lived. One or more trees were also growing in the centre of these largest plots. The earth used was extremely rich, and this being kept in a moist state by its proximity to the water and capillary attraction, (the elevation above it being not over a foot), the gardens were productive of the choicest vegetables and flowers, including also maize.

The gardens of the present day are very different affairs. They do not float, but, on the contrary, are composed of strips of solid ground, usually about 15 by 30 feet in extent, although some are larger.

These plots are intersected by small canals, through which visitors are propelled in canoes. They are constructed by heaping up the earth about two feet above the water. Willows and sometimes poplars and silver maples, also a species of cane, are often growing along their banks to keep them from washing down.

The nearest gardens to the City of Mexico are along La Viga Canal, a public waterway, about forty feet in width and of varying depth. Its source is in Lake Hochimilco, two and a half miles south of the city, whence it flows through the town and by a circuitous route to Lake Texcoco. The gardens are located where the ground is naturally low or swampy.

All produce the choicest vegetables, flowers, and not infrequently fruits in great abundance, embracing nearly every variety grown in the United States, and others unknown there. Even in the ditches or little canals beautiful water lilies often line the way, while many of the plots are one mass of vari-colored flowers, the most common ones being roses, pinks, geraniums, poppies and fuchsias. The great variety of shades and the enormous size of many kinds astonish and delight the visitor from more northern latitudes.

The poppies are more attractive than the finest Northern peonies. On certain feast days every one wears a wreath made exclusively from these showy flowers.

The quick and luxuriant growth of the products is mainly due to the daily application of water, which is dipped up in gourds attached to long swinging and pivoted poles, and deftly thrown about.

Little is certainly known regarding the origin of these famous places. Abbe Clavigero says that when the Mexicans were driven from their native country, ages in the past, they were forced to occupy small islands in Lake Texcoco, where "they ceased for some years to cultivate the land, because they had none, until necessity and industry together taught them to form movable fields and gardens, which floated on the waters of the lake. These were the first fields which the Mexicans owned after the foundation of Mexico." The custom may have originated as above stated, but the following view, founded on a careful examination of some of the oldest works on Mexico, is advanced as the more probable, especially since the Mexicans still retained and cultivated the watery plots after their independence was again established.

For long ages the valley of Mexico was subjected to devastating inundations. The valley is about sixty miles in width, and is surrounded by a continuous wall of hills and mountains. The waters collected on these flow into six principal lakes. The Plaza Mayor, or great square in the City of Mexico, is elevated a few feet only above the nearest lake—Texcoco. In former times a prolonged rainy season caused the surplus waters in the other lakes, which have an elevation of from three to thirteen feet above the Plaza Mayor, to burst their banks and flow into Lake Texcoco, which, in turn, overflowed and flooded the valley. In June, 1629, the date of the last great flood, the city was covered with water to a depth of three feet, and it remained in that state for five years.

The regular fields were, of course, ruined whenever a freshet traversed the valley, and necessity finally compelled the people to depend upon floating gardens for a supply of produce at all seasons and to prevent a famine. These were moored in places where the rise and fall of the lake waters would not affect them. During the period when floods were looked for at any time these floating patches were very common, but when the city and valley were partially protected by a gigantic canal in 1789 (commenced in 1607), by which the main overflow was carried off in safety, they gradually disappeared, until at the present time nothing but the pretty name and stationary plots surrounded by water remain to perpetuate an ancient custom.

WHY THE WINDS OF MARCH GIVE PLACE TO SHOWERS.

The weather conditions prevailing in April indicate a transitional state between the winter and summer seasons, with the winter types, on the whole, more vigorous. The contrast between March and April may therefore be mentioned, in order to explain the modification in the weather now setting in. The most prominent feature on the whole, is the drifting of the Rocky Mountain area of high barometric pressure to the northeastward, nearly into the Lake Region, and the supplying its place by the more permanent area of low pressure that enters the region from the southwest, intruding northward from the Gulf of California. The result of this change is to transfer the discharge of cold air from the interior of the continent, where it still lingers near the Hudson Bay, from the western to the eastern side of the lakes. Hence sudden outflows of cold winds occasionally advance over the Middle States and New England, by which one is reminded that winter has not yet gone from those districts.

In contrast with these cold northwest winds of the east, it is found that strong warm winds prevail in the southern and the Rocky Mountain districts. They are often of great velocity and carry immense quantities of sand and dust over the plains to the northward. These may be called "southers," in distinction from the "northers" of winter, which prevail in Texas and Arkansas. An attendant feature of the south wind is to carry the lines of equal temperature, the isotherms, rapidly to the northeast, from Texas to the lakes, causing hot weather in the Mississippi and the Missouri Valleys, often in unseasonable severity. This process may go so far as to make conditions for severe local storms, thunderstorms and tornadoes in Missouri, Iowa, Illinois, and would no doubt do so more frequently if the air were sufficiently charged with moisture, which does not always happen at this time in the spring.

At any rate, such a marked interchange of cold and warm winds in the Central Valleys is an important part of the April weather, and it is shown by rapid and wide oscillations of the barometer in those regions. There frequently occur great depressions of the barometer over the entire mountain plateau and slope, sometimes with high wind velocities, sometimes without them, even though steep gradients exist, in which there may be but little precipitation. This is probably due to the fact that in the increase of the general heat of the atmosphere in the middle latitudes the capacity of the air for greater quantities of moisture is increased, while there is also a corresponding diminution in the size of the cold masses that must be projected into the warm masses in order to produce a fall of rain. Hence strong gradients and wind do not necessarily imply much rain, and such storms may move to the Atlantic coast and go over, as it were, very dry, with only an occasional shower.

The showers of April may be simply understood. Instead of the atmosphere being collected into great sheets of cold and warm air which, as in winter, move eastward over the United States in a succession of waves, the cold and the warm masses become broken up into smaller portions or patches, which lie interspersed among each other in an irregular way. The contact of such masses of air, in smaller bodies, tends to cause local showers, and this condition lasts for a month or two, till the entire northern cap becomes warmed up, and then the summer conditions are fully established.

It may be not uninteresting to note the three ways that exist in the atmosphere of condensing the moisture, suspended in the form of aqueous vapor, into rain. The first consists in the cooling of the air by expansion when it rises from the lower to the higher strata, by which the cumulus and the cumulo-nimbus and nimbus clouds of summer are chiefly produced, and from whose bases the rain sometimes falls. The second is the intimate mixture of two masses of air having different quantities of vapor in them, but it has been shown that only small amounts of rain can in this way be produced, although very extensive fogs may be formed. The third is by far the most important, although in some respects a complex process, and it may be called direct cooling by contact.

One of the most important physical properties of air at different temperatures is a reluctance to mingle. Such masses will rather flow alongside in distinct strata, like oil and water, with contact on the surface. The effect of this is seen in many of the cloud forms that spread over the sky, showing exactly where the currents of different temperature touch each other. In the cyclonic circulation of the atmosphere which is to be referred primarily to the counterflow of currents from two adjacent high areas there is a powerful force that tends to compel a breaking up of the currents into shreds of air, warm and cold in quick alternation, in the interflow especially in the southeastern section of lows. Here the direct contact in the air of masses having moisture in suspension with the cold masses that are partially dry tends to form a rapid condensation, and hence rainfall. No doubt all these three processes are at work more or less simultaneously, but it is clear that direct cooling is the most efficient of all in producing ordinarily rainfall.—*The Philadelphia Press.*

SOME FACTS ABOUT BULLETS.

The first bullet used was probably a stone. Iron and lead bullets were not long in following. The latter were round, and were, of course, used in smooth-bore weapons. The calibre of all firearms was formerly much greater than now. The calibre of the first musket used was such that eight bullets weighed a pound. In consequence, the piece was so heavy that it had to be fired from a forked stick inserted in the ground.

Rifling was introduced while round bullets were still the only ones used. The grooves were straight, and were not intended to give greater accuracy to the projectile. They were merely to diminish the friction when it was rammed home.

By accident it was discovered that spiral grooves gave greater accuracy to the flight of the projectile, but the science of the day was unable to assign a reason for such superiority. In consequence, the form, number, and twist of the grooves depended upon the caprice of individual gunmakers. Now the cause has been explained, and the result of any alteration in the grooves can be foretold with certainty.

In 1729 it was found that good results could be obtained by using oblong projectiles. The great difficulty of loading the rifle, however, which was accomplished by the blows of a mallet upon the stout iron ramrod, prevented it from being regularly used in warfare. This difficulty was later overcome by using a bullet which fitted the barrel with only a moderate degree of tightness, but which was made to take the grooves by the expansive action of the powder upon a hollow base. The celebrated Minie bullet, used extensively during the civil war, was made on this principle. A sheet-iron cup was inserted in the hollow base for strength. The Minie bullet possessed great range and accuracy, but it had certain defects which prevented it from being extensively used in military service. It was compound in structure, and the iron cup was sometimes forced in obliquely, thus producing unequal expansion.

The bullet used by our army at the close of the war was in one piece, and, therefore, an improvement on the Minie. It was .58 in. calibre, and weighed 500 grains. The bullet of the Springfield rifle, which was adopted in 1869, and has just been superseded, is .45 in. calibre, and weighs 500 grains. The bullet of the new magazine rifle weighs but 220 grains, and has a calibre of .30. The new navy rifle has a calibre of .236. So from the first use of firearms we see a steady reduction of calibre and weight of bullet, which have been accompanied by increased velocity, range, and accuracy. It is impossible to predict whether the limit has been reached, but it is believed that it has been.

Our new bullet is a radical departure from any other type heretofore used. It is a cylindrical bolt with a rounded head, nearly four diameters in length. It is made of nickel steel, with a jacket of German silver.

There has been a deal of discussion and experiment to find out the destructive effect of the small calibre bullets now used as compared with those of twenty years ago. The result seems to be that at short and long ranges the effect upon bones is explosive, while at mid ranges a clean perforation is made. Should the bullet not encounter a bone, however, the wound is cleaner and the shock less than with the old projectile. What the effect of all this will be upon battles of the future cannot be foretold with certainty.

Prof. Hebler, the greatest authority in Europe on rifles and rifle shooting, has just invented a tubular bullet, which he claims to be a success. The object of such a bullet is to reduce the surface exposed to the air in front, and thereby increase velocity and range. Hebler's bullet is curved inward at both ends, with its channel widening funnel like. The conical rear end is fitted into a pasteboard shoe, which has a prominence projecting into the channel of the metal. The shoe acts as a guide, centring the bullet in its passage to the muzzle. It then drops to the ground. Prof. Hebler is very enthusiastic about his new bullet, with which he has been experimenting for twenty years.

Patched bullets are extensively used by marksmen, though never in war. They are made smooth, without grooves, and from three to six thousandths of an inch smaller than the bore of the rifle. The diameter is increased to the required size by rolling a thin paper patch about the bullet. There is a difference of opinion about the relative merits of patched and unpatched bullets. For hunting the latter are preferable, however, for they cannot be injured by moisture. In target practice some wonderful scores have been made with patched bullets, and many expert marksmen will use nothing else.

The common idea of an express bullet is one having an explosive at the point. This, however, is the exception rather than the rule. Properly speaking, the express bullet is made like any other, except that the point is deeply hollowed. The object of this is to make the bullet flatten out, or "mushroom," when it strikes, thereby increasing the shock, making a larger and more freely bleeding wound, and preventing escape. The hole may be strengthened by a copper tube, or simply filled with wax. Heavy charges of powder are used to increase the effect. The range of the express bullet is small, for it will not travel long "point on." It is a formidable affair, however, and is much used in hunting large game. For obvious reasons its use in war is prohibited by the law of nations.—*From the New York Sun.*

RUBBER SHOES SIXTY YEARS AGO.

To make a satisfactory purchase of a pair of rubber shoes sixty or more years ago, was an undertaking requiring the accredited keenness of a "Philadelphia lawyer." Boston, Mass., was then headquarters of the rubber trade, the largest importers being found there, where, besides supplying the regular trade, the commission merchants held rubber auctions at stated seasons. Notices sent abroad secured a full attendance of boot and shoe dealers from the large cities.

Most of the rubber, and the best, came then, as now, from Para, South America, or along the Amazon river, where natives procured it by tapping the trees. Clay and wooden lasts of various sizes were dipped in the cream-like liquid, the coating being dried by a dense smoke exactly as is done today. When the several dippings were over, the shoes were stamped on the toes in fancy designs, more or less elaborate, taken off the lasts and stuffed full of rice hulls and hay; the tops were then sewed together with twine or coarse thread.

Two of about the same size were tied together, and these ill-assorted pairs were packed in wooden boxes of all sizes and shapes, mostly sugar boxes, and shipped to foreign ports. A boot and shoe dealer receiving a box would immediately consign it to the cellar of his store, where on being opened, the stitches would be cut, the hulls and grass emptied out, together with a few scorpions and other live stock such as frequently took passage in the shoes. The shoes were then turned wrong side out and after a thorough washing inside and out to free them of all adhering clay and dirt, were left to dry.

Then followed the tedious process of trimming and shaping them. Each shoe was turned over a wooden last—the one that seemed to be about the right size. If it was not sufficiently large, another would take its place. If too large, the shoe was heated and by extra exertion was often made to work down to the required capacity. Then with sharp scissors the edge was neatly trimmed and after being sponged with Japan blacking the shoe was ready for sale. Only about enough for one or two days' sales were made ready at one time.

Repairing and resoling rubbers was a very nice operation, requiring great skill and cleverness. The shoe was again put on a last, when the sole or part to be mended was shaved with a sharp knife until it was all fresh and adhesive, and then a similarly prepared piece of rubber was put over it, the fresh surfaces pounded together and then trimmed neatly around. The shoes being soft and easily injured, had to be frequently mended. They tore readily; stones and sticks penetrated the soles, heat softened them, cold stiffened them, and the sun discolored them; but notwithstanding all that, every woman and child, and many a man, was obliged to wear them through the muddy, slushy, and snowy seasons; so the sales were proportionally great.

Here and there may occasionally be found a man whose hand even now bears the marks of trimmings done on "gums" during the days of his youth, but there are comparatively few people living who remember the old time rubber shoes with their stamped toes—which were considered a valuable improvement over wool socks and Indian moccasins. —*Boot and Shoe Recorder.*

THE TYRANNY OF THE MOON.

Some notable cases of so-called moonblink, or moon blindness, were reported recently, the victims being sailors on board the ship *El Capitan*, which had just returned to New York after a long cruise in Chinese and Japanese waters. These men, we are told, were in the habit of lying on the deck at night, with their faces turned upward, and as a result were stricken with temporary blindness. During the day time they could see well enough, but at night they could see nothing. This singular affliction beset them as long as they remained in the warm countries.

As to the cause or exact nature of this disease no explanation is to be found in medical works. Sailors themselves believe that it is caused directly by the moon, and many who have looked into this subject of lunar influence agree with them. One thing is certain—moon blindness was recognized as a curious malady many years ago, and by one, who evidently wrote after careful consideration, was attributed directly to lunar influence. Martin in his "History of the British Colonies," a book published many years ago, says:

"I have seen in Africa newly littered young perish in a few hours at the mother's side, if exposed to the rays of the full moon; fish become rapidly putrid, and meat, if left exposed, incurable or unpreservable by salt; the mariner, heedlessly sleeping on the deck, becomes afflicted with nyctalopia, or night blindness; at times the face is hideously swollen if exposed during sleep to the moon's rays; the maniac's paroxysms are renewed with fearful vigor at the full and change, and the cold chill of the ague supervenes on the ascendancy of this apparently mild yet powerful luminary. Let her influence over the earth be studied; it is more powerful than is generally known."

The author italicizes this last sentence, showing how important he deemed it. And this man, be it noted, was not a fortune teller, nor the seventh son of a seventh daughter, but a sober-minded historian and traveller, who gives us the results of his own experience.

Why he calls moon blindness "nyctologia" is not clear. The word is not to be found in standard dictionaries, and the only explanation is that it is a misprint, for "nyctalopia," which is correctly derived from the Greek, and signifies damage to the eyes at night time.

That the moon and sun have a boundless influence on the health of all persons born in this world cannot be denied. Indeed, it is claimed by those who have spent years in studying the subject that it is impossible for any person to die unless the sun or moon is afflicted by some malignant planet. The moon, afflicted in the sign of the Ram, invariably affects the eyesight. There are certain fixed stars, also, which threaten the eyesight. A person born when the moon is in conjunction with the Pleiades, Proserpine, or Antares will very probably either be born blind or will receive some injury to the eyes at some time in life. This will especially be the case if either Saturn or Mars, both of which are malignant planets, be at the same time in conjunction with Regulus.

That the moon, whose zodiacal sign, by the way, is the tropic of Cancer has an extraordinary influence over animal and vegetable matter in tropical countries has been pointed out by more than one observant traveller. Thus in Demarara, we are told, "there are certainly thirteen springs and thirteen autumns in the year, for so many times does the sap of trees ascend to the branches and descend to the roots. For example, wallaba, a resinous tree, common in the Demarara woods, somewhat resembling mahogany, if cut down in the dark a few days before the new moon is one of the most durable woods in the world for house building, posts, &c. In that state, attempt to split it, and with the utmost difficulty it would be riven in the most jagged and unequal manner that can be imagined. Cut down another wallaba, that grew within a few yards of the former, at full moon and the tree can be easily split into the finest smooth shingles of any desired thickness or into staves for making casks, but in this state applied to house-building purposes it steadily decays. Again, bamboos as thick as a man's arm are sometimes used for paling, &c. If cut at the dark moon they will invariably endure for ten or twelve years; if at full moon they will be rotten in two or three years. Thus it is with most, if not all, forest trees."

The English language bears testimony to a belief in lunar influence. How else can we account for the words lunatic and moon-struck?"—*From the Boston Herald.*

A WORD WITH THE DOCTOR.

That longevity is promoted by friction there can be little doubt. The declining energy and decay from age appear to arise, or, at all events, are accomplished and accelerated by the gradually decreasing energy of the circulation, and the use of the flesh brush restores energy to the parts. It is, therefore, recommended as a panacea for premature decay and all the diseases depending on it. It takes but a few minutes to give a vigorous rubbing to the entire body on jumping out of bed in the morning, and the beneficial results will amply repay the time and trouble.

Sulphonal is a good remedy for insomnia.—Take fifteen grains in hot milk or water at bed time and repeat the dose in an hour or two, if necessary. This remedy is a harmless one, and can be used without fear of acquiring a habit detrimental to health.

Experiments with toasted coffee prove it to be a powerful means of rendering harmless and destroying animal and vegetable effluvia. If a room needs a disinfectant, simply carry a coffee roaster, in which a pound of coffee has been newly-roasted, through it. But the best mode of using the coffee is to dry the raw bean, pound it in a mortar, and then roast the powder on a moderately heated oven or tin plate, until it becomes a dark brown color. Then sprinkle it in sinks and cesspools, or expose it on a plate in the room.

One part acetic acid to seven parts water, rub well into the scalp once a day, will induce a new growth of hair.

For canker sore mouth, one tablespoonful of salt, one of alum, half teaspoonful of borax, and as much blue vitriol, two tablespoonfuls of honey and a pint of strong cider vinegar. Simmer over a slow fire in an earthen vessel, then put into bottles. Use this frequently with a swab.

Great are the achievements of contemporary science in the department of therapeutics. No one who has undertaken to raise a family can fail, or at least should fail, to be thankful for antitoxine. It has really annihilated the worst terrors of diphtheria, and grateful voices rejoice in it wherever it has been used. Its success revives hope that the wise men will presently learn to deal effectually with the bacilli of consumption, and of cancer, too, if it should turn out, as begins to be suspected, that cancer is a communicable disease.

When the thumping sensation begins in the head take equal quantities of pure cayenne pepper and flour; mix them up with water to form a smooth paste thick enough to spread like a salve. Put this upon a piece of soft paper and apply it to the back of the neck just below the edge of the hair. In warm weather it is best to wash the neck with a cloth wet with soap and water, as the oily perspiration may interfere with the action of the plaster. One great advantage of cayenne pepper plaster over mustard is that while the latter frequently blisters, the former never does so, no matter how strong it is applied. In the use of mustard, if the skin is broken, all treatment must cease until it heals, but with pepper when the plaster loses its effect another may be applied without unpleasant consequences.

For earaches, that are so common to children just now, put a few drops of vaseline in a teaspoon and hold it over the gas to heat. Hold the spoon in the hollow of your palm for a second, and when it ceases to burn you, pour it in the child's ear, making it lie on the other ear, so that the oil will be retained for a moment or two. Then put some cotton in the ear. It will give almost instant relief, for the heat is excellent and the vaseline loosens up the dry wax in the ear.

An English surgeon claims to have relieved ninety-eight patients out of one hundred in cases of rheumatism by making a liniment of equal parts of wintergreen and olive oil. He applies it to the part, keeping it covered with oiled silk and flannel. He says the pain is relieved in from four to six hours. We advise any one who is afflicted with rheumatism to give this remedy a trial. We feel that it will be efficacious.—*From The American.*

SOME REMARKABLE RIVERS.

It is a recognized fact in science that very few great rivers have been thoroughly explored by going up stream. For nearly 2000 years travelers and explorers endeavored to discover the sources of the Nile by ascending that wonderful river. But by the time they had reached the difficult part of the stream their supplies and energy were exhausted, and they could go no further. It is only by seeking the sources of rivers by overland routes that explorers meet with success. It was in this manner that Henry M. Stanley traced the route of the Congo, in Africa. In this way of procedure Frederick Schwatka was enabled to float down to Yukon, and Speke found the secret of the river Nile.

One of the most curious rivers that has come to the knowledge of men is the Webbe Shebeyli, of Eastern Africa, a deep and rapid stream. Although it flows for hundreds of miles through fertile lands the immense volume of water never reaches the sea. A short distance north of the equator the river is lost in a desert region, a few miles from the Indian Ocean.

Some of the more recent explorers of Alaska and British America claim that the Mississippi can no longer be regarded as the largest river on the North American continent. This distinction is claimed for the great Yukon river. According to Ivan Petroff, who spent over two years in Alaska, collecting materials for the last census, the Yukon empties into Norton Sound about one-third more water than the Mississippi pours into the Gulf of Mexico. The Yukon basin comprises the largest part of Northern Alaska, and 600 miles from its mouth the river is a mile wide. The Yukon river is over 2,000 miles in length.

Travelers report that in Algeria there exists a small stream which the chemistry of nature has turned into ink. It is formed by the union of two rivulets, one of which is very strongly impregnated with iron, while the other, meandering through a peat marsh, imbibes large quantities of gallic acid. Letters have been written with the natural compound of iron and gallic acid, which forms this small yet wonderful stream.

The Rio de Vinagre, in Colombia, is a stream the waters of which, by admixture with sulphuric acid, become so sour that the river has been appropriately named the Rio de Vinagre, or Vinegar river.

The Orange or Gariep river, in Southern Africa, rises in the mountains which separate Natal from the Orange Free State. The length of this stream is 1,000 miles. Its banks abound in various valuable woods, and around it are found rich copper ores. In this stream are many varieties of fish which are found until the river passes through a rocky region containing copper, below which the water is said to be poisonous, almost instantly killing the fish that venture near it.

"China's Sorrow," a curious name for a river, is the title bestowed upon the great Hoang Ho, which rises in the mountains of Thibet, and follows a wonderfully circuitous channel for 2,500 miles to the Yellow Sea. The waywardness of this mighty volume of water makes the river a constant source of anxiety and danger to the 170,000,000 of people inhabiting the central plain of Asia. It is known to have suddenly changed its course nine times. It has moved its mouth four degrees of latitude each time, emptying its vast floods in different directions, and finding a new channel for itself, where scores of towns and villages have stood.

Another remarkable river is the Indus, a great stream in Hindustan. It rises in Thibet, and its course is a wonderful one. On reaching Sussi, its most northern point, it turns southward, loses itself in the hills and reappears at Takot, in Kohistan. The Indus is 1,700 miles in length. After receiving the waters of many tributaries its channel grows narrow, and here it divides into many channels, some of which never returned to the parent stream.

That classical river the Ganges is erratic in its course, like the Hoang Ho. It is prominent both in the religion and the geography of India. It varies not only from season to season, but from year to year, and frequently exchanges old passages for new ones. It has been said that the Ganges delivers into the sea every year 534,000,000 tons of mud, sand and other solid matter.

PRESIDENT AND CABINET.

"In all important matters the President is consulted by all the secretaries. He is responsible for all executive action, and everything that is out of the routine receives his attention. Every important foreign complication is usually discussed with him, and the diplomatic note receives his approval. The same thing is true of each of the departments. Routine matters proceed without the knowledge or interference of the President; but, if any matter of major importance arises the Secretary presents it for the consideration and advice of the President. Only matters of great and general importance affecting the general policy of the administration are discussed in the Cabinet meetings—according to my experience—and votes are of rare occurrence. Any Secretary desiring to have an expression upon any question in his department expresses it, and it is discussed; but usually questions are settled in a conference between the President and the head of the particular department. There is a yielding of views, now on one side, now on the other; but it must, of course, follow that when the President has views that he feels he cannot yield, those views must prevail, for the responsibility is his, both in a constitutional and popular sense. My habit was to give an afternoon to each Cabinet officer, on a fixed day of the week. These meetings were chiefly given up to the consideration of appointments, but if any other matters were pending, and deemed by the Secretary of sufficient importance, they were presented and discussed. The labors of a Cabinet officer are incessant and full of responsibility. His time is largely taken up with calls, and, like the President, he must, out of such fragments of time as he can secure, manage to study and decide the important questions that are daily presented to him. Certain appointments, chiefly of a clerical character, are by law given to the heads of the departments, and with these the President usually refuses to interfere, though often urged to do so. It was my practice to refuse to send any card of recommendation to a Secretary, though I spent many a weary hour explaining to friends why I could not do so."—*Ex-President Harrison in March "Ladies' Home Journal."*

THE PROBABLE ORIGIN OF A WELL-KNOWN SEA STORY.

The atmosphere in the vicinity of the Cape of Good Hope has that peculiar power of unequal refraction which produces the spectral mirages so well known to the early settlers on the great plains and to all travellers and explorers in desert regions. This unequal blending of the rays of the light gives rise to what are known as "spectral loomings," by which is meant the apparent suspension of ships and other objects in midair. The peculiar properties of the atmosphere over that portion of the ocean mentioned have been known since men first "rounded the Cape" in their voyages from western Europe to the Indies, and the regular appearance of the mirage at that point is responsible for the legend of the "Death Ship," otherwise known as the "Flying Dutchman."

According to the story, a Dutch Captain, homeward bound from the East Indies, met with long-continued bad weather while trying to "round the Cape." This series of squalls was coupled with other circumstances which made "turning the Cape" next to impossible. The wind was "dead ahead" and the weather was dark and foggy. At the time when the brave little Dutch Captain was making a final effort to get off in a northwesterly direction, and was about to make a failure of it, the mate and the sailors advised him to turn back and seek shelter in a neighboring harbor until the gale was over. But this he refused to do, swearing that he intended to "turn the Cape" if he had to beat back and forth along that shore until the day of judgment. For this burst of profanity, so the tradition says, he was doomed to steer against the blustery winds forever. The sails of his ship, so those who believe in the legend say, have become bleached with age, and its sides and bottom worm-eaten and decayed in the long struggle which has ever since been kept up between the cursed vessel and the elements. The little Dutch Captain and his crew, like all persons living under a spell, continue to exist, knowing their condition but unable to help themselves. Ship captains, who have sighted the doomed vessel time and again during the past century and a half, report that the crew of the cursed Dutch vessel appear to be living skeletons. Yet they continue to live under the blighting effects of what was brought on by their master's rashness. They cannot lower a boat they are so weak. Yet they occasionally hail passing vessels, imploring to be rescued from their awful fate.

Such is the story of the "Flying Dutchman," which no doubt, originated through ignorant, superstitious sailors viewing the mirage in awe-stricken terror.—*From the St. Louis Republic.*

EMERY.

Emery is one of the few valuable rocks not yet produced in important quantities in America. Large amounts are yearly brought from Turkey and the Greek Islands, where it has been quarried since history began. Its wonderful properties were no secrets to the ancients, who used it for cutting and polishing; but their methods of working are not certainly known. Curiously, modern methods of mining this substance have made no progress, and to this day ledges of emery have been heated by huge fires and the hot rock cracked by douches of cold water.

During the middle ages, and for many years afterward, the properties of emery, while not forgotten, could not be utilized. The old art of working was lost and ingenuity was unable to give useful forms to this intractable substance. It long defied every effort. Slowly, however, emery again came into use, first as a polishing and cutting powder, and later, in the form of small grains, was attached to fabrics like a sandpaper. Means were afterward found to cement and mould its small particles into wheels. Emery wheels soon came into use, their remarkable cutting properties proving at once the great industrial importance of the invention.

Years elapsed, however, before the emery millstone could be made; but, at length, this too was accomplished, and a practical emery stone was brought out in England. Later, Yankee ingenuity improved upon this and produced the present successful rock emery millstone, which is built up of large blocks of emery set in strong metal.

These millstones grind fast because the emery face is always sharp, and as they are not damaged by heat, they can be run at high speed.

Many new uses will doubtless be found for emery; but probably it can take no more important place than that of the emery wheel and the emery millstone, the one cutting and polishing in the shops the hardest surfaces and the other grinding the surface to any degree of fineness.—*Scientific American.*

SPARROWS' SAGACITY.

A bevy of sparrows, evidently the advance guard of an extensive foraging party, flitted into the quiet precincts of Carondelet street in New Orleans recently. Some men were cutting the fresh spring grass from the banquette, and the sparrows were eager for a raid on the upturned soil. There must have been nearly thirty birds in all. Perhaps a half-dozen or so who were the leaders of the party, settled on the ground at once and began investigating the find. The rest, twenty-five plump little fellows, stopped up above to await orders from the leader, stringing themselves out in a row on a telephone wire, chattering and chirping most gleefully.

Suddenly a woful thing happened. The innocent-looking wire became surcharged with electricity, and like a veritable thread of destruction, sent the merry little birds to their death without a warning. Quicker than it has taken to tell it, the little tragedy was enacted, and twenty-five plump little sparrows lay dead in the gutter. The birds on the banquette looked on aghast. Finally, amid much chirping and fluttering, having satisfied themselves that their fellows were indeed dead, they evidently settled upon a plan to save from destruction the rest of the party that was already appearing in installments up and down the street.

One little fellow, with a noticeably shrill voice and general fussiness, seated himself on top of the wire post, well out of harm's way, and called out a note of warning to the birds as they drew near. The rest of the leaders divided up, one going up, another down the street, and so on, challenging every fresh arrival in the block and spreading the news of the tragedy.

This was evident, for during the whole day, though innumerable sparrows feasted on the upturned bugs and worms on the banquette, not another one was seen to rest on the electric wires overhead.—*From the Philadelphia Times.*

THE CARE OF THE AGED.

When a man or woman passes seventy years of age, great care should be given to the conditions surrounding him or her for the prolonging of life. The vital forces are greatly enfeebled at that period of life, and the powers of resistance in consequence of age are the weakest. A man of three score years and ten, and over, is like an old machine that by proper care given to its condition has been kept running many years, and is still able to do work, but its wheels and axles and pinions are much worn and are rickety, and if it should be pushed, even to a small extent, in excess of its diminished powers, it breaks down and cannot be repaired, for every part of it is shattered. But if worked carefully and intelligently by a person who understands its condition and knows its capabilities, it can be kept in action a much longer time than would be possible if a careless engineer controlled it. In these fast times, however, it is generally not profitable to husband the resources of an old machine. But this is not true as regards our old men and women. It is desirable to hold on to them as long as possible, and if we can succeed in prolonging their lives five or ten years, or more, it will greatly enhance our happiness.—*Medical Review.*

NEW INVENTIONS.

PNEUMATIC PUMPING.

No. 555,785. Michael Mish and William Foster, Brooklyn, N. Y. *Patented March 3rd, 1896.* Fig. 1 exhibits the form of the apparatus employed for ordinary low lifts, and Fig. 2 shows the arrangement designed for high lifts. The water is raised by means of compressed air, which is forced by a compressor *C* through a pipe b^2 and jet b' into a deflecting cup *b*. The part of the pump containing the jet and deflector is submerged as shown. The jet of air is spread out into a thin sheet and turned upward, and as it passes over the edge of the deflector it engages the surrounding water and drives it upward, after the manner of an ejector. The tendency of the air to escape in bubbles from the bottom of the pipe is thus overcome, and the depth to which the pump must be submerged is consequently much less than in other forms of pneumatic or "air lift" pumps. In Fig. 2 the lifting action is enhanced to any desired extent by means of the ejector *Z*. The compressed air, which is also supplied to the annular space *e*, escapes through the narrow passage *g* in a thin sheet, and drives the water *f* upward with great force. The ejector *Z* and deflector *b*, working together, are able to operate lifts of considerable height, with a very moderate depth of sump.

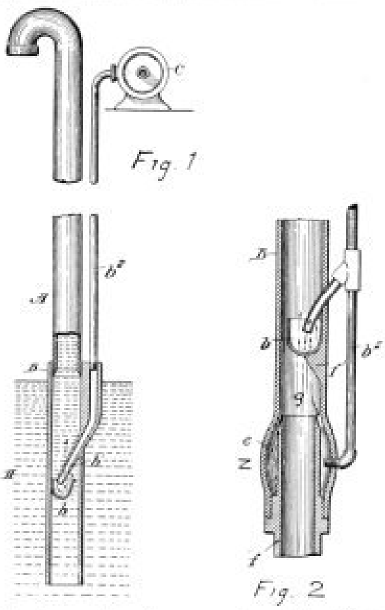
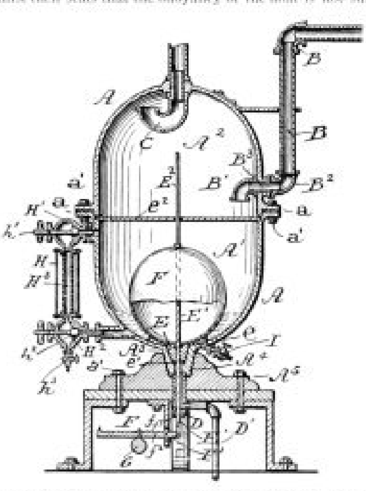


Fig. 1 Fig. 2

STEAM TRAP.

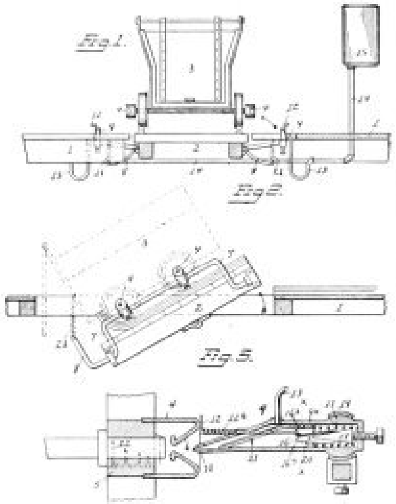
No. 555,708. Felix T. Howell, Birmingham, Ala. *Patented March 3rd, 1896.* The steam pipe enters the receiver *A* at *B*, and delivers the wet steam in a downward direction. As the steam turns to go out by the pipe *C*, the entrained water is thrown down to the bottom of the receiver. The escape valve is controlled by a float *F*. It is a common defect of float valves, that high steam pressure forces them so firmly against their seats that the buoyancy of the float is not sufficient to lift them; and if they are adjusted to work properly at a given pressure, they will fail to operate under a higher pressure. This defect is overcome by means of a lever *F*, and balance weight *G*, which serve to lift the valve and float. The valve stem passes down through the water outlet *D*, and through a suitable stuffing box, and rests upon the short end of the lever. The buoyancy of the float can be quickly adjusted to any steam pressure by shifting the weight *G*; or the trap may be drained at any time by moving the lever *F*.



LUBRICATOR FOR MINE CARS.

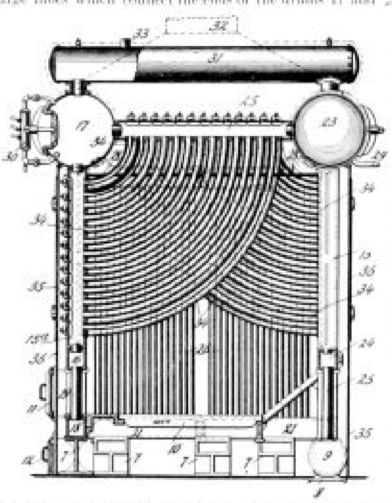
No. 553,484. George Maurer, Hilldale, Penn'a. *Patented Jan. 28th, 1896.* Fig. 1 is an end view of the apparatus; Fig. 2 is a side view, and Fig. 3 is a section on a larger scale of the oiling nozzle.

This apparatus is designed to oil the car wheels while the car is being dumped. Each side of the dump is fitted with a bent bar or rock shaft 7, which has an arm 8, attached by a spring 21 to a convenient stud in the floor. Each rock shaft carries two automatic oil feeders, which enter the caps 4 on the ends of the wheel hubs 5, and squirt in a small amount of oil every time the dump is turned down to empty a car. Each oil feeder is connected by a rubber tube to an oil pipe which extends to the tank 15. When the dump is level, the oilers lay down, as in Fig. 1. The oiling nozzle is pointed as shown, and the oil valve 11 is held shut by a spring 17. A rod 12 touches the end of the cap 4 and opens the oil valve, and its inner end is provided with a latch, which is regulated by the conical screw 18, so that it will let go the oil valve, and will hold it open but a moment, thus avoiding an excess of oil, in case the car remains in an inclined position for an unusual time.



STEAM BOILER.

No. 553,700. Robert R. and Harry L. Zell, Baltimore, Md. *Patented Jan. 28th, 1896.* The view given is a vertical section of the boiler, from front to back. The boiler is built up on a square frame or base, which is composed of a front header 18, two side headers 21, a rear header 24, and a mud drum 9. The corners of the structure are composed of four large tubes which connect the ends of the drums 17 and 23 with the base frame. These tubes are cooler than any of the others, and the water travels downward within them. The sides of the combustion chamber are composed of vertical tubes 26, set in double rows very close together. The upper part of the combustion chamber is occupied by curved water tubes 34, which connect alternately the front vertical headers 13*a*, and the rear headers 13, to the horizontal top headers 25. These top headers adjoin and close the top of the combustion chamber. The front and rear headers 13*a* and 13 have spaces between them, which are fitted with removable doors, for cleaning purposes. The water is carried at the middle of the drums 17 and 23, and the steam is dried in the top drum 31. The boiler is encased with plates which are lined with non-conducting material. All joints of tubes and headers are made by expanding the tubes or nipples into bored holes.



DEVELOPING POWER FROM STEAM.

No. 554,073. James M. Miller, and W. L. Collins, Vacaville, Cal. *Patented Feb. 4th, 1896.* Steam from an ordinary boiler is applied by the pipe *B* to the injector *C*, which is supplied with water from any convenient source by the pipe *E*.

The water which is delivered by the injector is passed through the large pipe *D*, which runs through the cooling tank *I*. Here all steam which is mingled with the water is condensed, and the body of water is made solid and free from bubbles. The upper part of the pipe *d* is an air chamber. The water is delivered through a jet *K* upon a water wheel of the Pelton type *F*, to which it imparts its momentum. The jet *K* is made double, as shown in Fig. 2, for the purpose of securing a solid, unbroken stream of water upon the wheel.

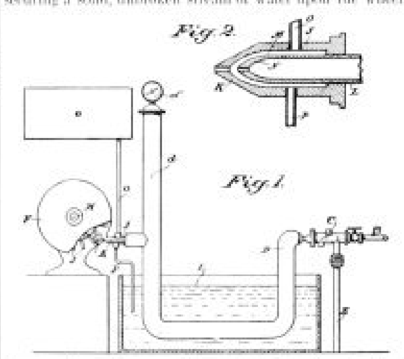
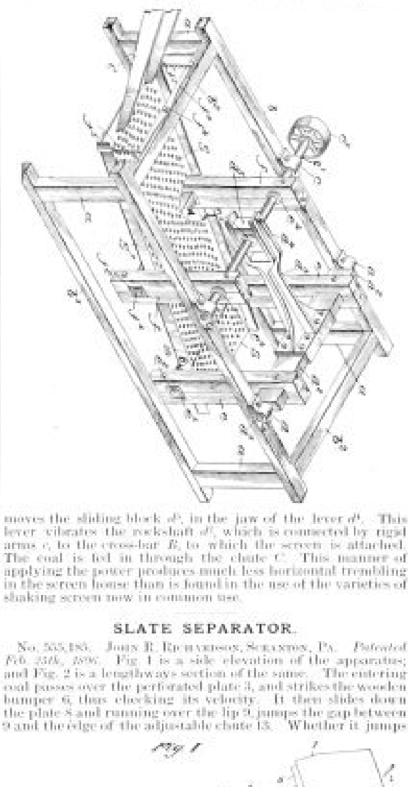


Fig. 2. Fig. 1.

The pipe *O* supplies a small amount of water from the tank overhead, and the surplus runs into the condensing tank, through the pipe *P*. It is claimed that the energy of the steam, at the injector, is converted into static pressure of water in *D*, to such an extent that notwithstanding the loss of power at the wheel, this mode of applying steam power is reasonably effective.

SHAKING SCREEN.

No. 555,262. David E. Phillips, Mahanoy City, Pa. *Patented Feb. 25th, 1896.* The screen is shaken vertically and horizontally at the same time. The vertical movement is imparted by the eccentrics c^2, pitmen *f*, and the cross-bar *A*. The horizontal motion is imparted by the eccentric c^3, which



moves the sliding block d^2, in the jaw of the lever d^1. This lever vibrates the rockshaft d^3, which is connected by rigid arms *e*, to the cross-bar *B*, to which the screen is attached. The coal is fed in through the chute *C*. This manner of applying the power produces much less horizontal trembling in the screen house than is found in the use of the varieties of shaking screen now in common use.

SLATE SEPARATOR.

No. 555,185. John R. Richardson, Scranton, Pa. *Patented Feb. 25th, 1896.* Fig. 1 is a side elevation of the apparatus; and Fig. 2 is a lengthways section of the same. The entering coal passes over the perforated plate 3, and strikes the wooden bumper 6, thus checking its velocity. It then slides down the plate 8 and running over the lip 9, jumps the gap between 9 and the edge of the adjustable chute 13. Whether it jumps

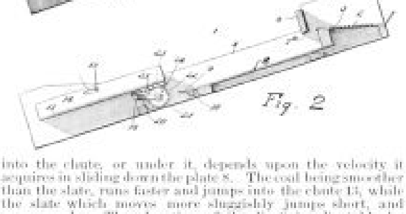
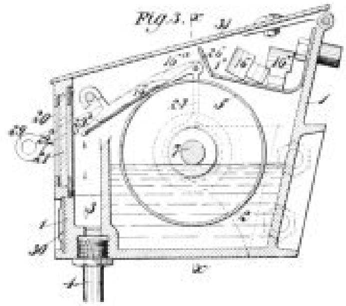


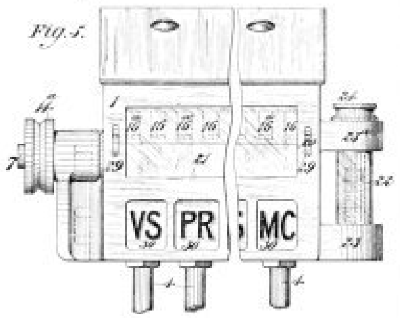
Fig. 1 Fig. 2

into the chute, or under it, depends upon the velocity it acquires in sliding down the plate 8. The coal being smoother than the slate, runs faster and jumps into the chute 13, while the slate which moves more sluggishly jumps short, and passes under. The elevation of the lip 9 is adjustable by means of the locking handle 12. The chute 13 may be moved forward or back by means of the pinion 24 and rack 25, and is held in place by the lock handle 26. The handle 17 is attached to a bent bar or crank 16, which serves to elevate or depress the upper end of the chute 13. All of these parts may be adjusted readily, while in operation.

LUBRICATOR.

No. 554,891. John I. Thornycroft, London, Eng. *Patented Feb. 18th, 1896.* Fig. 3 is a cross section of the apparatus, and Fig. 5 is a broken front view of the same. This device is designed to feed oil regularly, and by positive means, to a large number of bearings at the same time. The oil is picked up by a smooth drum 5, which rotates in the oil in the chamber 2. The oil is taken off the drum and delivered in drops into the end of separate oil ducts 3, by means of blocks 16 and 16². These blocks are quite narrow, and are provided with grooves in their edges as shown. They are suspended by hooks *a*, from a rod 6, and they rest lightly upon the revolving drum. The blocks 16² are longer than those marked 16, and may be thrown out of service by lifting

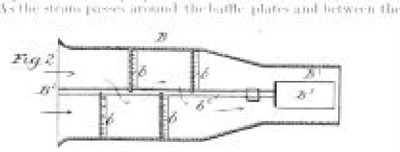


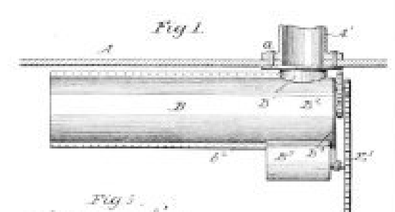


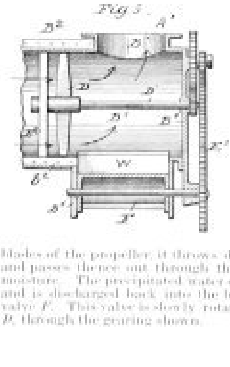
them clear of the drum, by means of the rod 26 and handle 29. These extra blocks are used only for heavy bearings that are liable, at times, to require an unusual amount of oil. The drum is rotated by means of the pulley 14, and the amount of oil in the case is shown by the glass tube 22. Each duct is provided with a tablet or label at 30, which shows the destination of the oil.

STEAM SEPARATOR.

No. 554,892. Charles W. Baker, Montclair, N. J. *Patented Feb. 4th, 1896.* Fig. 1 is a side elevation of a separator in position for work; Fig. 2 is a horizontal section along the center of the main drum *B*; Fig. 5 is a vertical section through the outlet end of the separator, on a larger scale; and Fig. 6 is a cross section of the valve chamber. This separator is placed inside of the boiler, and is designed to separate the entrained water from the steam before it passes out from the boiler. The body *B*, is oval in section, and is made with several baffle plates *b*. The part *B'*, is circular in section, and is provided with a propeller wheel *D*, and a draining valve *F*. As the steam passes around the baffle plates and between the



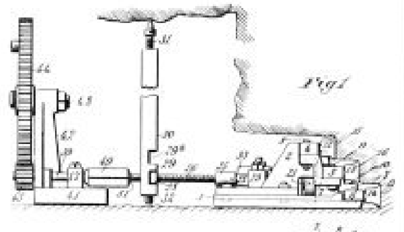


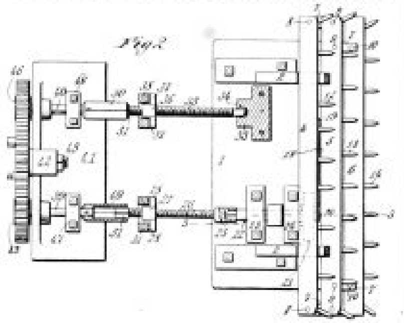


blades of the propeller, it throws down the entrained water, and passes thence out through the discharge *A'*, freed from moisture. The precipitated water collects in the chamber *W*, and is discharged back into the boiler, at intervals, by the valve *F*. This valve is slowly rotated by the propeller wheel *D*, through the gearing shown.

MINING MACHINE.

No. 555,218. George W. Lutes, Lisbon, Ohio. *Patented Jan. 21st, 1896.* Fig. 1 is a side view of the machine, and Fig. 2 is a top view of the same. The cutters 12, 13 and 14 are attached to three parallel bars 4, 5 and 6, which are fixed at different levels, as shown. The cutter bars are fastened together, so that they operate as one, and they are reciprocated lengthways, while pressed against the coal. The cutters operate by scraping. The main frame 1, upon which the

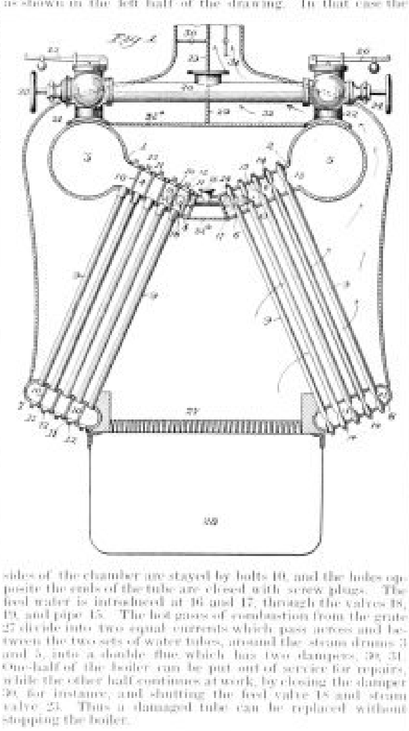




center bars are mounted, is pushed forward by means of two screws 35 and 26. The latter screw is used as a shaft to transmit motion to the crank 21, which reciprocates the cutter bars by means of the pitman 18. The thrust of the screw is resisted by the jacks 30. Power is applied to the screws through the gear 44 and pinions 45 and 46. The wheel 44 may be turned by hand, or may be driven by some convenient motor. The under cut made by this machine is quite high, and is stepped, as shown, to facilitate the breaking down of the overhanging coal.

WATER TUBE BOILER.

No. 556,108. Horace See, New York, N. Y. *Patented March 10th, 1896.* The figure is a vertical cross section of the boiler. The tubes are arranged in two sets, one on each side of the furnace. The tubes 9 extend from the base boxes 7 and 8 to the steam chambers 4 and 6, which connect with the steam drums 3 and 5. The tubes may be expanded into both plates of the base boxes, as shown on the right half of the drawing; or they may be expanded only in the single plates as shown in the left half of the drawing. In that case the



sides of the chamber are stayed by bolts 10, and the holes opposite the ends of the tube are closed with screw plugs. The feed water is introduced at 16 and 17, through the valves 18, 19, and pipe 15. The hot gases of combustion from the grate 27 divide into two equal currents which pass across and between the two sets of water tubes, around the steam drums 3 and 5, into a double flue which has two dampers, 30, 31. One-half of the boiler can be put out of service for repairs, while the other half continues at work, by closing the damper 30, for instance, and shutting the feed valve 18 and steam valve 23. Thus a damaged tube can be replaced without stopping the boiler.

COAL TIPPLE.

No. 555,365. Thompson B. DeArmit, Turtle Creek, Pa. *Patented Feb. 25th, 1896.* Fig. 1 shows the general arrangement of the screening and weighing apparatus; and Fig. 3 shows the mode of shutting off the screens so that the coal may pass over them without being separated. The coal is dumped into the upper end of chute 3. The bottom of this chute 3' is composed of a screen of 1¼ inch mesh. The miners are paid only for the coal which passes over this screen, that which passes through being reckoned as waste. The screened coal passes onward into the screen box 4, where it is further separated by the screen 15, the egg coal passing into the

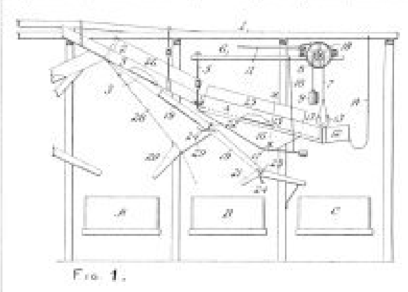
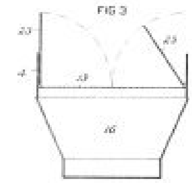


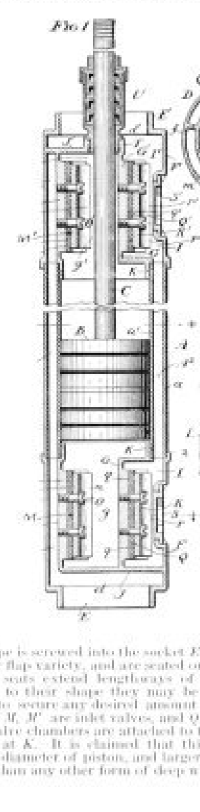
Fig. 1.

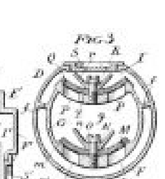


hopper 16. This screen box and hopper are suspended by rods 5, from a scale beam 6, and by chains 7 from the pulley 8 and counterweight 9. The screen box is closed at the lower end by a hinged section 12, and the coal is released from it by raising the brake lever 11, and allowing the end to sink until the chain 14 tightens and pulls the part 12 upward, thus opening the joint between it and the screen box. At the same time the chain 18 opens the gate 17 and releases the egg coal from the hopper 16. The stuff which passes through the screen 3' passes over another screen 19, which takes out the nut coal; the slack drops into the hopper 28, and may be delivered into the car *A* or *B* as desired. By means of the gates 22 and 23, the nut coal may be delivered into *A*, *B* or *C*. The screens 3' and 15 may be thrown out of use by turning down the hinged plates 25, 26. The run of mine may then be shipped by car *C*. When it is desired to ship run of mine, while still paying the miners on the basis of 1¼ inch screened coal, the plates 26 are raised, and the gates 22, 23 are set so as to deliver all the screenings, except the slack, into the car *C*.

PUMPS.

No. 555,200. William D. Hooker, Chicago, Ill. *Patented Feb. 25th, 1896.* Fig. 1 is a vertical section of the pump; Fig. 3 is a cross section through the valve chamber; and Fig. 5 is a plan of the valve seat. This pump is designed for pumping bored wells. The main barrel is double; the space *A²* between the working cylinder and the outer shell is divided by partitions *f*, into two parts or passage ways. The





tail pipe is screwed into the socket *E*. The valves are of the rubber flap variety, and are seated on concave seats as shown. These seats extend lengthways of the pump barrel, and owing to their shape they may be made of any length, in order to secure any desired amount of valve opening. The valves *M*, *M'* are inlet valves, and *Q*, *Q'* are discharge valves. The valve chambers are attached to the main barrel by screw joints at *K*. It is claimed that this construction affords a larger diameter of piston, and larger passage ways and valve areas than any other form of deep well pump.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 11. SCRANTON, PA., JUNE, 1896. With Which is Combined THE MINING HERALD.

THE OQUIRRH MOUNTAINS

OR THE MERCUR MINING DISTRICT, UTAH.

An Epitome of the Geological Survey's Report of the Region by Messrs. Emmons and Spurr. With Notes and Comments by Prof. Arthur Lakes.

Written for THE COLLIERY ENGINEER AND METAL MINER by Prof. Arthur Lakes.

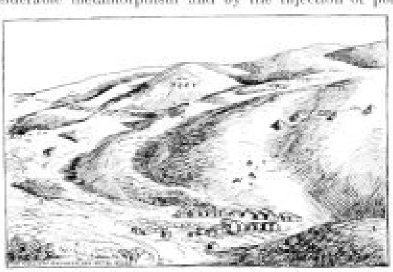
From the base of the Wahsatch mountains on the east, to the Sierra Nevada on the west, stretches an arid region called the Great Basin, so named because it has no external drainage to the ocean. This region was once occupied by two large distinct freshwater seas, which have gradually disappeared by evaporation, until at the present day only small salt lakes remain. The basin consists of broad level valleys, 4,000 to 6,000 feet above the sea, intersected by mountain ridges trending north and south, called the Basin ranges.

The Oquirrh range, in which is situated the Mercur mining district, is the first of these Basin ranges west of the Wahsatch mountains, and about thirteen miles distant from them. The character of the great basin is a sage brush and desert. A few small streams occur in the Oquirrh range, but insufficient for mining purposes. The range is thirty miles long and culminates in Lewiston Peak (10,628 feet) near its extreme end.

Utah has long been celebrated for its silver rather than its gold products. Hence the interest attached to the little gold mining district of Mercur.

Some of the most noted mining districts of Utah are the Bingham canyon, where placer as well as silver mining was carried on, but principally silver and copper. Ophir and Stocton, Camp Floyd and Tintic, have all been noted for their silver products more than those of gold.

The Oquirrh mountains are composed mainly of Carboniferous limestones and quartzites, which the forces of contraction acting in either direction have compressed into a series of complicated folds, accompanied by considerable metamorphism and by the injection of por-

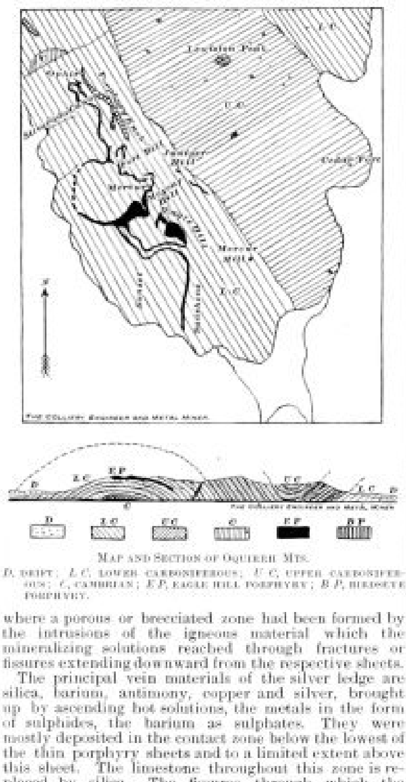


MERCUR BASIN, LOOKING SOUTH; MERCUR HILL ON RIGHT.

phyry dykes, together with subsequent mineralization in the more disturbed districts. The Lower Carboniferous limestones of Lewiston canyon constitute the ore-bearing horizon of the Mercur district. Associated with these are beds of clay shales. On the north side of Ophir canyon a peculiar arch of Cambrian quartzite has been uplifted by a fault.

There are no large exposures of eruptive rocks, such as result from surface outflows, but rather dykes and irregular intrusive bodies. In Bingham canyon the ore is found only in the vicinity of one of the bodies of porphyry that occur there. In the Mercur district the igneous rocks are mainly in thin sheets parallel to the stratification and immediately beneath these sheets the principal ore deposits occur.

According to Mr. Spurr there have been two distinct periods of mineralization in this district. During the first the silver ledge was formed, during the second the minerals of the gold ledge were deposited. In each period the minerals constituting the ore were deposited mainly along the lower contact of a porphyry sheet,



MAP AND SECTION OF OQUIRRH MTS.

D, DRIFT; L C, LOWER CARBONIFEROUS; U C, UPPER CARBONIFEROUS; C, CAMBRIAN; E P, EAGLE HILL PORPHYRY; B P, BIRDSEYE PORPHYRY.

where a porous or brecciated zone had been formed by the intrusions of the igneous material which the mineralizing solutions reached through fractures or fissures extending downward from the respective sheets.

The principal vein materials of the silver ledge are silica, barium, antimony, copper and silver, brought up by ascending hot solutions, the metals in the form of sulphides, the barium as sulphates. They were mostly deposited in the contact zone below the lowest of the thin porphyry sheets and to a limited extent above this sheet. The limestone throughout this zone is replaced by silica. The fissures through which the mineral solutions ascended have since been filled with calcite. There are two varieties of quartz porphyry. One, called Eagle Hill porphyry, is very like the Leadville white porphyry, the other, or birdseye porphyry, is like the gray Leadville porphyry.

Two ore-bearing beds about 100 feet apart exist near the middle of a great series of limestone strata. The lower of these two beds consists of quartzite, or dark silicified limestone, brecciated and porous, carrying silver and antimony and copper, but no gold, and is called the silver ledge. The upper, known as the gold ledge, is a zone of decomposed bleached red or yellow limestone and shale, containing realgar and cinnabar, with a low but uniform percentage of gold. The silver ledge was easily traceable, owing to the hardness of the rock, causing it to protrude as a ledge, but the gold ledge was more difficult to follow, being marked at the outcrop only by a slight ocherous appearance in the rock, the gold never being visible. The Geological Survey discovered that certain seams or beds of shale-like matter in the mines, forming the roof of the ore bodies, are highly altered sheets of a white porphyry, called, from the name of the hill, Eagle Hill porphyry. Three of these sheets, one above the other, were traced in the ore-bearing zone, an important point bearing upon the oft-observed connection of igneous rock with ores.

The vein materials of the gold ledge are realgar cinnabar and pyrite with gold, and with these are associated barite and calcite and gypsum. The deposits are formed at the intersection of zones of north-east fracture, with the lower contact of the middle of the three porphyry sheets, reaching a thickness of 20 feet and thinning out away from the fracture fissures. Some of the principal fissures are still open, and show no evidence of filling or erosion by circulating waters. These fractures cut across the silver ledge, and as a rule do not extend above the gold ledge.

The average section of the mining area of the rocks of the Mercur Basin are in ascending order:

1. Blue-gray, Lower Carboniferous limestone occupying the bottom of the canyons, 200 feet of which are exposed.

2. Above this a series of interbedded limestones and calcareous sandstones, 600 feet thick.

3. A very thick blue-gray limestone, 5,000 feet thick. This limestone contains in its beds narrow strata of shale at intervals, which furnish the water supply of the district; also in its lower portion it carries the ore horizons.

4. Above this another series of interbedded limestones and sandstones, like the lower series, 5,000 feet thick. Altogether in the Mercur Basin a total thickness of 12,000 feet of strata.

The two porphyries found in this region are very dissimilar in appearance. The Eagle Hill porphyry is nearly pure white, with a pinkish tinge, showing small crystals of quartz and mica in its fine grained feldspathic ground mass.

The porphyry is generally much decomposed, the weathered rocks are stained various shades of red and yellow. It occurs in two principal sheets in Eagle Hill parallel to the bedding of the limestone and overlying the ore bodies. As the hills around Mercur are not covered by drift, it is easy for the prospector to trace continuously the line of contact of the eruptive with the sedimentary rock. If the actual boundary cannot be seen, it can generally be identified by fragments lying on the surface which correspond pretty closely with the solid rock below. In the weathered

MERCUR BASIN, LOOKING NORTH; MARION HILL IN LEFT FOREGROUND.

rock the limestone chips are of the typical dark blue color while those of prophyry are cream yellow, brown or green, and on a bare hillside the line separating the two can be rapidly traced. If the hill is steep a talus may hide the contact.

The birdseye porphyry forms two eminences called Porphyry Hill and Porphyry Knob. Its color is grey with distinct light grey feldspar crystals, mica and quartz crystals speckled all over it and forming the greater part of its bulk. In decomposing, the ground mass becomes deep olive green color. The Eagle porphyry weathers into small sharp fragments but the Birdseye decomposes gradually in place. A large part of the rocks in the Mercur basin contain traces of gold showing a very slight but widespread mineralization. Of the rocks analyzed by Mr. Spurr, the great blue limestone showed a trace of gold; black shale, a trace of gold; altered weathered limestone, small quantities of gold. The two porphyries showed the largest traces of gold, about 0.01 oz. to ton.

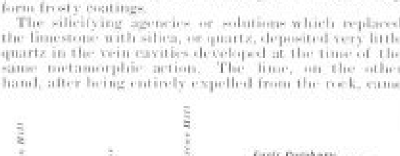
The pure white crystalline calcite veins, although in no way connected with the chief mineralization, showed small quantities of gold 0.025 oz. to ton. This shows a slight general mineralization of the rocks of the basin. In certain localities, the mineralization has been so great as to furnish ores of gold and silver which have been profitably worked. In all cases these localities are at the contact of porphyry sheets with inclosing limestone. The exact line of contact, however, is not always profitably mineralized. In localities only is it rich forming ore bodies. In these contact ore bodies are two groups. In the first the lime is hardened at contact with the porphyry and is called by miners "black quartz." It shows chloride of silver, antimony, copper, carbonate and barite.

In the second group, lime and porphyry are both decomposed and changed into a soft rock called "shale" by the miners. It is nearly black but oxidizes to light yellow. The first group contains only very small quantities of gold with silver; the second no silver, but enough gold to be valuable. This latter ore carries much arsenic and mercury sulphide. The silver ledge is a zone of highly silicified rock at the contact of the lowest of the three minor sheets of Eagle Hill porphyry. The outcrop of this zone is very prominent throughout the basin, having been fashioned by erosion into a steep cliff conspicuous from a distance. The rock at the contact is much brecciated, the fragments, composed of cherts and silicified limestone, are enclosed in cement of white calcspar and barite. The contact of the ledge with the porphyry is very distinct, greater erosion of the porphyry leaving a shelf 20 feet wide. In the limestone below the silver ledge are numerous narrow vertical calcite veins which do not appear in the broken rock above or in the porphyry, showing that the formation of fissures and cracks since filled with calcite was not later than the intrusion of the porphyry. The breccia of the silver ledge was formed by the friction of the intrusion of the porphyry sheet against the limestone walls, and the filling up of the spaces between the fragments with crystalline calcite followed closely. The fissures in the limestone below may have been opened up at the time of the intrusion of the porphyry and have been filled by calcite at the same time as the breccias of the silver ledge. A noticeable hardening and darkening of the limestone is found at this upper contact for 5 feet. Three sheets of porphyry are developed on this hill, one 20 feet thick associated with the silver ledge is the lowest. Above this a smaller sheet much decomposed associated with the gold ledge; and above this a third sheet which does not seem mineralized.

In the Silver Cloud mine the silver ledge outcrops as a broken, flinty zone with irregular veins of barite. The drift at the bottom of the shaft shows a strongly fractured zone. The fractures are open and large, without vein filling, and indicate the action of faulting. These fissures contain no ore, and were later in origin than the vein filling of the silver ledge. The rock cut by these planes is much metamorphosed. It is an altered, cherty, broken limestone, dotted with small blotches of calcite or barite, and is cut by veins of calcite in a network. Large geode cavities occur, lined with crystals of dogtooth spar. Barite is common in bunches or pockets, veins or geodes. Malachite and copper stains occur. In some of the crevices a good deal of kaolin clay occurs. The open fissures were later in formation than the calcite veins and geodes, as they cut abruptly through these. The softer and decomposed porphyry is actively prospected for gold.

The mineral which accompanies the ore is a flinty, impure quartz called black quartz by the miners. Complete silicification, or changing of rock into a quartz-like condition, was one of the first stages of metamorphic action. The quartz is always in this massive amorphous condition; crystals are rare. The quartz which occurs in cavities has been produced by dissolving agencies. On the walls of cavities and in irregular cracks, it may form frosty coatings.

The silicifying agencies or solutions which replaced the limestone with silica, or quartz, deposited very little quartz in the vein cavities developed at the time of the same metamorphic action. The lime, on the other hand, after being entirely expelled from the rock, came



Geological Section of Mercur Basin.

in and crystalized as pure white calcite in numerous fissures and cavities opened by the silicifying solutions, forming veins several inches wide, lining walls of large cavities with beautiful crystals of dogtooth spar. These veins are found everywhere and are indicative of considerable mineralization, more than is contained in the silicified limestone alone.

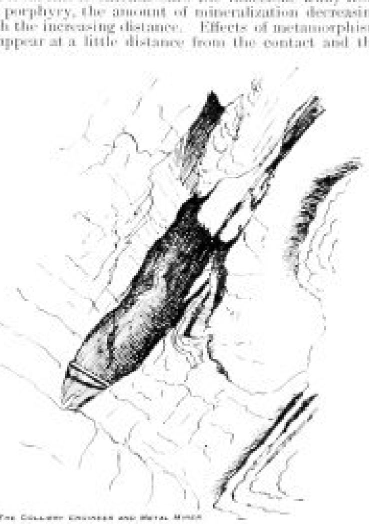
This does not show, however, any close connection in deposition between the limespar and the ores. It is the honeycombed condition of the rock which is significant of the intensity of the action accompanying or inducing mineralization, and the calcite, coming later, filled by a slower process the cracks and cavities formed by the eating away action of the mineralized solutions. The calcite veins are not intimately associated with ore; usually they are barren. (In the volcanic region west of Cripple Creek, Colo., we have observed many large calcite veins in the lava, but have not as yet heard of them being productive.)

Barite, or heavy spar, on the other hand, is closely associated with the ores. It occupies irregular spaces in the rocks. At the contact of barite with chert, or flint, there is a zone of transition from one to the other, suggesting that barite may have replaced the limestone at the time of silicification, and that barite and silica were introduced at the same time. This mineral is a sure sign of considerable mineralization (a fact which we have observed in many of the mines of Colorado also). The barite is often the gangue in which the metallic sulphides that furnish the ore are imbedded.

Antimony occurs in thin radiating crystals and bunches. Films of various forms of copper occur, closely associated with silver. In the neighboring Tintic district copper forms a conspicuous part of the ore and an important product. Arsenic occurs in the gold ledge in the form of the sulphide realgar. Chinese talc, or gouge, as the miners variously term it, occurs as at Leadville, a white or rusty clay resulting from the decomposition of the feldspars of the porphyry. It is a silicate with a varying amount of sulphate of alumina. It is compact, semi-translucent, white and soft, and hardens and becomes opaque on exposure to the air.

The silver ores in the silver ledge, all carry small quantities of gold. The silver ore is small films of chloride of silver disseminated through altered silicified limestone.

Mineralization has taken place at the contact between porphyry and limestone. The point of greatest mineralization is in the limestone directly on this contact and from this it extends onto the limestone away from the porphyry, the amount of mineralization decreasing with the increasing distance. Effects of metamorphism disappear at a little distance from the contact and the



Natural Open Fissures in Face of the Drift, Silver Cloud Mine.

limestone below is unaltered. The zone of alteration is from 10 feet thick, to 50 in places of great mineralization. The mineralized zone does not deviate from this line of contact. It does not extend into the porphyry or follow any steeply dipping zone as would be caused by planes of fracture. There are no fractures or water channels in the zone through which the mineral solutions could have come except the minor fractures in the limestone at contact with the porphyry, and they were merely the result of friction caused by the intrusive porphyry.

The mineralizing agents were heated waters, circulating along the contact, containing silica, barium, antimony, copper and silver. The work of these solutions was the removal of lime and deposition of silica by process of gradual replacement, without destroying the original features of the rock. In many places, as here, the effect of these solutions is shown in the alteration of the limestone in the vicinity of the ore-deposits to chert or silica, the derivation of one from the other being quite clear. Quartz in the vicinity of eruptive rocks accumulates in compact crystalline masses or in a jasper or chalcedonic condition. So the silicification of the limestone of the Mercur district at contact with porphyry is only a common result of metamorphic action.

Mr. Spurr gives a very clear explanation of the way in which ore bodies are deposited in connection with igneous rocks and igneous activity, which will apply to Leadville and Cripple Creek, Colorado, and many other igneous localities of ore deposit.

The water which lavas contain is not emitted till the actual moment of solidification, when, by process of crystallization it is separated out and becomes conspicuous by its fluidity. When the solidification takes place at the surface it forms clouds of steam which issue from cooling lavas, but where the rock is forced into a molten state between the strata, so that the water which is separated is still under sufficient pressure to keep it in a liquid state, there results intensely heated solutions capable of a great degree of corrosion. These solutions act most violently at the contact, and become rapidly cooled on penetrating the adjoining rock, and in case of small bodies of igneous rock at a short distance, become incapable of much altering power. Lavas possess a wonderful power of retaining for a very long time and up to the moment of solidification, considerable quantities of water, showing that heat does not exclude the action of water and that the latter has even at high temperature an affinity for the silicates of lavas. The width of the zone of alteration following the contact of an igneous with a sedimentary rock, varies constantly with the nature and size of the intruding mass, and the nature of the sedimentary rock, and other conditions. Along the same contact between the same eruptive and sedimentary rock, are great differences, and at points where the eruptive rock forms reentrant angles the zone of alteration is greater than at projecting angles. All such phenomena are exemplified in the Mercur contact zone.

The phenomena of the silver ledge indicates brief intense action, highly heated waters capable of great metamorphosing influence, as shown by complete replacement of limestone by silver and by great corrosion of the rock. The mass is full of irregular cavities of dissolution, especially where alteration has been gradual. Some of these are several feet in diameter, others are small. Whether the material removed from these spaces was lime or silver such a riddling of the rock indicates very active agents of solution.

The barium found in the silver ledge as heavy spar, was derived from the cooling eruptive mass. Barium is of frequent occurrence in igneous rocks especially in the feldspars of the porphyry, and most of the metals found in veins are present in the minerals composing igneous rocks. On crystallization, a portion of them would be taken up by the forming minerals; and the small amount, left dissolved in the heated waters expelled at the same time, would be carried out and deposited in the enclosing rock when conditions were favorable.

Mr. Spurr considers the ores were deposited as at Steamboat Springs, Nevada, by ascending hot solutions. The solutions, exuding at every point from the cooling porphyry, found in the limestone a zone where the passage of solutions was made relatively easy by the opening of fissures and formation of breccias. These waters heated and under great pressures would move along this broken weakly resisting zone, and whenever possible also in an upward direction. Where the porphyry sheets cut across the strata the waters would rise rapidly. Where circulation was retarded, accumulation and mineralization would be greatest. The greatest mineralization does not attend the greatest sheets of porphyry, but often the contrary, the neighborhood of the smaller sheets being most mineralized.

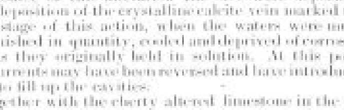
SUMMARY OF SILVER LEDGE GEOLOGY.

Silver ores characterize a zone of altered limestone, following the contact of Eagle Hill porphyry along the lower surface of the lowest sheet of igneous rock. This zone is marked by silicification of the limestone by presence of barite, antimony, copper and silver. The copper is a carbonate, the silver a chloride, associated with sulphide of antimony.

There was great straining and fracture at time of introduction of the eruptive rock. Breccias are common and many fissures cross the altered rock, but do not persist far into the mass of unaltered limestone, and there are cavities formed by the corrosive action of circulating solutions. The walls of these cavities and fissures are covered with calcite, whose large crystals show a slow, quiet period of formation. The calcite was deposited after the main alteration.

Silver and copper and antimony were originally deposited as sulphides. The mineralizing agents were waters which contained silica and barium in solution, with small amounts of antimony, silver and copper. The gelatinous silica was deposited as quartz, the barium as sulphate, the metals as sulphides. The action was intense and brief, the waters highly heated. That the mineralization clings closely to the porphyry shows the waters were either derived from the igneous rock or had a common origin with it. The minerals which the waters deposited are such as would be derived from the porphyry. The water which accompanied the eruption was separated from the lava at the moment of cooling and found its way into the adjoining rock. It exerted a powerful soluble force on the soluble limestone, and in the course of this alteration the ores were deposited. The deposition of the crystalline calcite vein marked the final stage of this action, when the waters were much diminished in quantity, cooled and deprived of corrosive agents they originally held in solution. At this point the currents may have been reversed and have introduced lime to fill up the cavities.

Together with the cherty altered limestone in the ore zone, large veins of barite occur, sometimes in open cavities, into which the crystals of barite extend, and cinnabar coats these crystals. Much of the clay in this zone is altered decomposed porphyry. Faults occur not unfrequently, and the fault crack is filled with mineral,

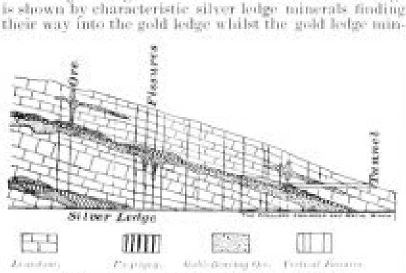


Section Along Geyser Tunnel, Mercur.

which shows that the mineralization, which introduced the gold in some mines, took place after the faults were developed. (The gold may occur in combination with tellurium, as at Cripple Creek, Colo.) There is rarely over one-half an ounce of gold to a ton of ore, and three ounces is very rare. The greatest mineralization in the gold ores is at the lower contact of the thin sheet of porphyry next above the lowest, or silver ledge sheet, with the blue limestone. From the contact the ore descends, as at Leadville, downward into the limestone for a few feet without change, then falls off rapidly, so that the ore gives place irregularly to unaltered and barren limestone, carrying only a trace of gold. The ore is richest where the alteration is greatest.

The porphyry at contact shows many irregularities, rolling up and down along the course of the tunnels and above the limestone. Open fissures occur; also other fissures filled with calcite, belonging to an earlier period than the fissure; these are merely gash veins, whilst the open fissures mark a period of sheeting of the rock after the formation of the calcite veins, and are of greater length than the calcite ones, but often following a calcite vein as a line of least resistance. Mining stops at the lower contact of the altered porphyry, leaving a clear, quite regular wall. Below, the mineralization extends more irregularly and gradually into the limestone. Average thickness of available ore is 7 feet. A convenient distinction between the altered porphyry and altered limestone is the presence of calcite veins in the limestone, which are never found in the porphyry. The limestone in many cases shows profound fracturing and sheeting, and is open fissured. Where fissures are widest there is least mineralization, and where most sheeted and the fissure narrow, most mineralization occurs, ore solutions being detained in the narrow passages, whilst they passed rapidly through the wide ones, leaving no deposit above the contact alteration, and mineralization of the porphyry takes place slowly. The altered porphyry always contains a trace of gold. Where the alteration is least and mineralized zone of limestone narrowest, the ore stops abruptly at the contact with the porphyry. Occasionally the whole porphyry sheet may be sufficiently impregnated with low grade ore to be mined bodily (as in the Little Johnny, Leadville). Shrinkage causes certain planes of weakness to develop in the limestone, causing vertical cracks, so that the rock is divided into blocks, between which the mineralization penetrates inward. The vertical fissures, before alluded to, have been instrumental in opening up the rocks through which they pass to the mineralizing currents. Sometimes (like at Cripple Creek) they are crowded close together, forming a "sheeted zone." Along such zones the pulverized rock crumbles readily and is carried away, leaving the open fissures we have described. The mineralization of the gold ores occurred at a period later than the mineralization of the silver ledge and the formation of the calcite veins which are so abundant in all the rocks.

The vertical fissures existed before the arrival of the gold and were the channels for this mineralization. That the gold ledge was mineralized after the silver ledge is shown by characteristic silver ledge minerals finding their way into the gold ledge whilst the gold ledge min-



GEOLOGICAL SECTION OF PART OF MERCUR MINE.

erals do not transgress into the silver ledge. The porphyry had nearly reached its present state of decomposition before the minerals were deposited. One of the marked signs of alteration of the porphyry is like what is common at Cripple Creek, Colorado, viz., curious patterns and concentric markings of red and yellow oxide of iron on the porphyry ground mass. The limestone in alteration shows the removal of calcite and replacement by silica with a great deal of more or less porous chert, which Hills observes is due to the leeching out of the siliceous element of the limestone and concentrating them in the form of chert nodules.

The realgar, which is a conspicuous mineral in the deposits, is a sulphide of arsenic of a rich reddish brown color altering on oxidation to a brilliant yellow. The impregnation of the limestone with mineral took place by filling cavities from which quartz or calcite may have been leeched out, also by actual metasomatic substitution or replacement, as at Leadville.

The ores of the gold horizon were originally deposited as sulphides, and all stages of the transition from sulphides to oxides can be seen where the ores are exposed.

The agents which brought about the mineralization were ascending, rising from below, till they met the sheet of altered porphyry, when they spread out along the under contact and so produced mineralization. The channels along which they rose were the open vertical fissures. Where these fissures are thickest the mineralization is greatest.

In the case of the silver ledge the agents of mineralization were heated waters derived from the lava at the time of consolidation. In the case of the gold ledge the phenomena being somewhat different; we may suppose that the mineralizing agents were more in a gaseous than liquid condition. The various metals found associated with the gold, such as antimony cinnabar, etc., were just such as would easily pass into the state of vapor and the last also to be deposited. The phenomena of origin and ore deposit seems very much like that going on at the Steamboat Springs, Nevada, which we have before described in THE COLLIERY ENGINEER AND METAL MINER.

After the eruption of the porphyry a disturbance brought about a set of vertical fissures establishing a communication with a body of uncooled igneous rock at an uncertain depth and affording a vent for moist volcanic vapors. The limestone at the lower contact of the porphyry had been partly silicified at the period of the primary mineralization and in the succeeding period had been rendered porous by the leaking out of a large part of the residual lime. Along this porous zone the vapors spread out, and becoming cooled deposited the gold and other minerals and penetrated slightly upward into the altered but less porous porphyry. Lava retains heat an enormous time after eruption. At Jorullo, in Mexico, a bed of lava emitted vapors from fissures 100 years after its eruption. Such would supply both heat and vapor for mineralization. A point worth noticing in cases of mineralization in volanic areas like Cripple Creek, Colorado, and elsewhere, is that "after eruptions a vast body of heated lava may remain beneath the bottom of the crater in which the process of solidification goes on slowly for an indefinite and very long period affording a continuous source of aqueous vapor charged with various mineral substances."

THE GOLD LEDGE.

The gold bearing horizon is about 150 feet above the top of the silver ledge. It follows a sheet of Eagle Hill porphyry of slight thickness and much decomposed and, as is so often observed in mines, the porphyry owing to decomposition is not easily recognized even as an igneous rock, but this material can be traced through various gradations to a distance from the mine where it passes into a true unaltered and undoubted porphyry. The gold is invisible and only gauged by assays. It is associated with arsenic (realgar), cinnabar, iron pyrites, barite, calcite, gypsum, Chinese talc. It is associated too with a zone of broken cherty, silicified limestone and with a sort of black fissile rock resembling a black shale. This is greatly mineralized especially by realgar, iron pyrites and gold averaging half an ounce gold to ton. The ore zone is well defined and 20 feet thick. In some mines the ore is in an oxidized condition and the gold free. In others it is contained in the original sulphide. The occurrence of the gold in a limestone zone is unusual.

Limestones are not as a rule favorite depositories for gold as they are for lead and silver, but the present case is paralleled by that of the Little Johnnie at Leadville, Colo., where in a somewhat similar way the gold is at the contact zone between porphyry and limestone. Doubtless in both cases the poryhyry is more responsible for the gold than the limestone, which is merely a convenient receptacle for any kind of ore by reason of its solubility and cavernous structure. It is the tea cup which holds the tea, but not the teapot which pours it out; or, perhaps a better simile, it is the vessel into which the liquid is poured from the sponge which holds it. The black shale is an alteration of the porphyry sheet. The decomposition and leaching out of the sulphide ores gives a peculiar aspect to the mineralized zone which makes it easy to be followed. The oxidized ores have been the most worked and readily yield up their gold to the influence of cyanide of potassium or the cyanide process. In the sulphide state, however, the ores have to be roasted and the sulphur driven off, a process which entails some loss.

SUMMARY OF THE GOLD LEDGE.

The gold ledge is developed as a mineralized zone on the lower part of Mercur Basin, mainly on Mercur and Marion hills. It consists of an altered limestone, following the under contact of a thin sheet of altered white porphyry. The mineralization of the limestone along the contact of this upper porphyry is not continuous, but varies from 20 feet to nothing. The lines of greatest mineralization coincide in direction with a set of nearly vertical northeast fissures, forming "shoots" or channels. The ores are of two classes, oxidized and sulphides. The former are extracted by the cyanide process, the latter by roasting. In the sulphide zone the ores are soft and shale-like; in the oxidized zone, soft and easily pulverized; both contain much scattered chert. The amount of gold in the ores rarely exceeds three ounces to the ton; silver is absent.

The mineralization of the gold ledge took place after the silver ledge, by gaseous rather than liquid agents, which ascended along open vertical fissures from some uncooled body of igneous rock below, impregnated the zone at the lower contact of the porphyry sheet already made porous from the effects of the mineralization of the earlier silver ledge, with arsenic, mercury and gold.

Coal Fields of China.

The North China *Herald* of January 17, 1896, quotes a writer of "The Situation" in the Peking and Tientsin *Times*, of the 28th ultimo, as saying: "There are symptoms indicating that the Chinese near Peking are awakening to the advantage of employing foreign engineering knowledge and machinery. Considerable coal fields extend over a vast area of the mountains north and west of the capital, at a distance of about 100 li from it. They have hitherto been worked by the stereotyped, irrational, mole fashion, so characteristic of Chinese. When the natives discovered the coal seams on the sides of the mountains, they commenced digging into them, and in some places they have penetrated as far as 8,000 feet, in others only a few hundred feet, when they were stopped by water, with which difficulty they have been entirely unable to cope, and the mines have consequently, in many cases, been abandoned. We are glad, however, to hear that some rich Chinese, stirred by the railway movement, have entered into contracts with a foreign engineer to develop the mining possibilities of the northern districts.

"China's coal fields are exceeded by none but those in America, and in a more distant time they will have equal effect on the commerce and manufactures of the world. The cost of sea freights has been low enough to allow the coal to be carried to distant countries and sold more cheaply than coal from nearer sources; but the construction of railways, the improvement of navigable rivers and other means of transport are, in many countries, entirely altering the conditions of the coal trade, and in Japan, India and Australia the native coal is rapidly superseding the imported coal, and the same change will eventually take place in South Africa and in China when the coal deposits are developed."

Boiler Test.

We have received from Messrs. H. E. Collins & Co. a handsome illustrated pamphlet, which is a report of a comparative test made by the Pittsburg Testing Laboratory, Ltd., for Currie Furnace Co., as to the relative efficiency of Cahall and Babcock & Wilcox boilers. The results of the test show higher efficiency for the former than for the latter boilers.

THE VULCAN EXPLOSION.

A Description of the Mine and the Conditions Existing Therein.

The Work of Rescue and an Investigation of the Probable Cause of the Disaster.

Written for THE COLLIERY ENGINEER AND METAL MINER by David Griffiths, State Mine Inspector.

On Tuesday morning, February 18th, 1896, an explosion occurred at the Vulcan mine operated by the Atchison, Topeka and Santa Fe Coal Company, one and one-half miles southeast of the town of Newcastle, Garfield county, Colo., which resulted in the death of forty-nine men including James Harrison, the mine foreman, John Funke, assistant mine foreman and Thomas Larrigan, fire boss.

The coal bearing strata at this mine pitches about 47½° and the strike of the seam is southeast and northwest. There are several workable seams of coal on the property, the Wheeler and Allen seams having an aggregate thickness of about 70′.

The mine is under the management of Mr. C. J. Devlin, general manager of the Atchison, Topeka and Santa Fe R. R. Co.'s coal properties; Mr. Robert T. Herricke, local superintendent and Mr. Joseph Fletcher the company's mine inspector, who inspects and reports on all the mines owned by the company about every three months. The immediate officials at the mine were the foreman with an assistant and three fire bosses who each worked eight hour shifts.

The accompanying map of the mine on a scale of 400′ to the inch will enable the reader to arrive at a good idea of the conditions existing at the mine and will make clear the statement of my investigations as to the cause of the explosion. The mine is opened by a slope, *A*, driven on a pitch of 5° 43′ for 250′ through the surface wash and the measures underlying the Wheeler seam. At this point the bottom slate of the seam is encountered and the slope is continued in a direct course on the bottom slate diagonally across the pitch. From the point where the slope strikes the bottom slate of the seam the average pitch is about 30°. The air course, *B*, parallel to the slope, is driven on nearly the same pitch as the slope with the exception that near the surface it is driven on about 40° pitch thus shortening the distance for the connection at the crop entry. The total length of the slope and parallel air course is about 840′ from the mouth.

At a point about 460′ from the mouth of the slope, the right, or west entry, *C*, is turned off on a pitch of 27°, forming a very short curve and a steep grade for haulage. Over this entry a wooden air bridge *D*, is constructed for the main slope air course and about 75′ above this air bridge a shaft *X*, is sunk from the top of the seam to the bottom of the parallel air course, and the right entry is driven to the west boundary line. At 250′ from the slope the right entry runs on the strike of the seam and a double parting about 13′ wide and 100′ long is constructed for the purpose of facilitating the haulage. This is shown at the point *E* on map.

At the outside end of the parting close to the point of strike, a cross-cut is driven to the top of the seam and from this point another air course *F*, is driven parallel to the entry and to the west boundary line. The upper and top slate air courses are connected by an air bridge driven through the solid coal across the main right entry at *G*. At 180′ from the outside end of the parting the first room or breast is turned off. In this entry there are eight rooms and sixteen chutes as shown on the map, and the inside room is driven up nearly on the boundary line. The distance from the point where the entry begins to run on the strike of the seam to the face is 710′. At a point 730′ from the mouth of the slope the left or east entry *H*, is turned off on an easy grade and curve. A parallel air course along the top slate is driven through the slope from the main slope air course (see *I*). The main left entry and parallel air course are about 920′ from the slope. In this entry there are eight rooms and sixteen chutes.

The rooms are all turned off the main entry and on the bottom slate of the seam; they are 40′ wide with 40′ pillars between them. There are two chutes to each room thus forming an entry pillar of about 25′ between the chutes. At a point about 30′ up the pitch the chutes are connected by a cross-cut and the face of the room is then formed. The miners take out from 7′ to 8′ of the coal seam and 40′ wide in the breast. There is a manway built on each side of the breast about 3′x 8′, or 24 sq. ft. sectional area for ingress and egress and for ventilation of the face of the workings. The rooms are driven up about 175′ from the entry and then stopped, after which all the cut coal is taken out of the room.

Another operation then takes place. Men selected for the purpose, called "top men," are put to work to cut the seam at right angles to the pitch and up to the top rock, then the whole thickness of the seam, about 45′ of coal, is blasted down and taken away through the chute below, care being taken not to draw out too much, so as to give the men something to stand on and keep them close to their work. On arriving at the top of the room in taking down the top coal, the breast is tapered off so that there will not be any point of it higher than the top cross-cut in the bottom coal. This is necessary because if the top coal was excavated higher than the air current there would be an accumulation of fire-damp. The first operation of working up the room is done by the yard and the top coal men are paid by the day. As soon as the top coal operation is finished all the coal is taken out as rapidly as possible because if left for any length of time it is liable to spontaneous combustion. The coal is loaded by men selected for that purpose who are paid by the day.

At the time of the explosion the mine was ventilated by two fans *K K*, of the compressive type. One was a Guibal fan 12' in diameter with blades 5' 6'' in width and the other was a double Murphy fan 6' in diameter. These fans were capable of producing from 38,000 to 40,000 cubic feet of air per minute separately and from 54,000 to 60,000 cubic feet of air when working together. The interior of the mine was so arranged that if one fan was disabled the one fan would ventilate the whole mine. The right and left entries had separate and distinct currents of fresh air from the outside. Each current was again split in the mine thus giving a separate current for the room workings and the entries. The split currents joined at the face of the entries and returned through the main entries. Air crossings were built or formed in all practical points in order to avoid doors and to keep a continuous air current through the workings. The mode of ventilation and its distribution received great attention and was, in my opinion, well conducted.

The management recognized the danger incident to the presence of coal dust and took the following precautions. Under the brow of the hill and about 50' above the mouth of the mine three large wooden tanks *T*, were constructed, into which water from the Grand river was pumped. The tanks are connected with a 6'' wrought iron pipe and the pipes running into the rooms are connected to 4'' pipe on the entries which are reduced to 2'' in the rooms. Two-inch valves are used on the room connections; some of the rooms have pipes near the face but generally a hose connection is made and the hose is moved to the point of watering. The hose has a reducing nozzle and by the use of it every section of the mine can be reached from the nearest connection. The altitude of the tanks, which are about 330' or more above the entries, yields a pressure of nearly 140 lbs. to the square inch. There was a man engaged for the purpose of extending the pipes and sprinkling. I consider the system as good as can be adopted.

The subject of damping or sprinkling the dust in the mines of Colorado is gaining favor among the mine officials, and there are very few officials who do not recognize the importance of keeping the dust from contaminating the air current. Some of the extensive mines in the southern part of the state are now watering all their haulage ways and the officials state that great benefits have been derived; the quantity of air is increased and improved in quality, and besides there is a perceptible decrease of temperature in the mine. Where explosives are used to mine the coal the dust question is a matter of great importance and should not be neglected at any time, and it should be borne in mind that sprinkling is not sufficient to overcome this dangerous element. In order to be on the safe side the dust must be well watered. The Prussian Fire Damp Commission and other authorities say that the dust must be dampened with 50% of its own weight of water before any degree of efficiency is obtained.

Previous to the explosion I made several inspections of the mine in company with Mr. R. T. Herricke, superintendent, and Mr. Connors, who was then the mining boss, and invariably found the mine in good condition. At the time of one visit we discussed the question of safety lamps and the management informed me that they had decided on the use of the Mueseler lamp to replace the Clanny lamp then in use. I approved of the change, and that was the lamp used by all workmen except the fire bosses at the time of the explosion. On the whole I considered the mine in excellent condition and had no suggestion to make to the management whereby a greater degree of safety could be secured. There were no rooms in operation at the times of my visits, all places being worked in eight hour shifts in order to make speedy developments.

On September 20th, 1895, Mr. John D. Jones, Deputy Inspector, made an examination of every working place in the mine, accompanied by Mr. R. T. Herricke, superintendent, Mr. James Fletcher, inspector of mines in behalf of the A. T. & S. F. Co., Mr. James Harrison, mine foreman, and Mr. John Funke, his assistant. This was Mr. Harrison's initiation to the mine. He was anxious to see every place as to its condition, etc., and he was satisfied that everything was well conducted. Deputy Inspector Jones reported as follows: "Quantity of air entering per minute, 32,500 cu. ft. A current of air is carried through all the working faces, also a supply of water to sprinkle the rooms. The haulage ways are well timbered. A new fan will be put up in the near future which will undoubtedly be of great benefit."

This additional fan was put in operation on the 15th of October, 1895, and the two fans gave a combined volume of 50,000 cu. ft. of air per minute, with neither fan running at full capacity. We were notified of this by the officials and we felt assured that another safeguard had been added to the Vulcan mine. On February 8th, 1896, I made another inspection of the mine in company with Messrs. Herricke, Harrison and Funke. On this day the mine was not working. There were a few company men at work in No. 1 room on the left entry. I inquired of Mr. Herricke as to the condition of the mine previous to entering and he informed me that the mine was in better condition than ever before. We walked down the slope to the left entry and there met Mr. Harrison, and we examined the main and back entry. We then came back and went up to the top coal room where there were five men at work blasting down top coal. Here I found a good current of air and a hose for the purpose of sprinkling the dust. The dust had just been sprinkled at the time and six shots were charged ready to fire. We examined the highest point in the top coal with a Davy safety lamp but found no traces of fire-damp. I inquired if there were any more rooms in the mine working top coal and the answer was in the negative. We then came up the slope and the six shots were fired. By the time we arrived on the knuckle we heard the six shots in the top coal room going off quite distinctly. On leaving Mr. Herricke, Mr. Harrison asked me if I had any suggestions to make and I answered no, but that they had a mine to look after that required great care and attention. I did not visit all the working faces, but was satisfied from what I had seen that the local management was doing everything for the safety of life and property. In many cases where the miners are of the opinion that the officials do not comply with the law regarding coal mining we receive complaints, but in this case we have never received a complaint either by word or letter.

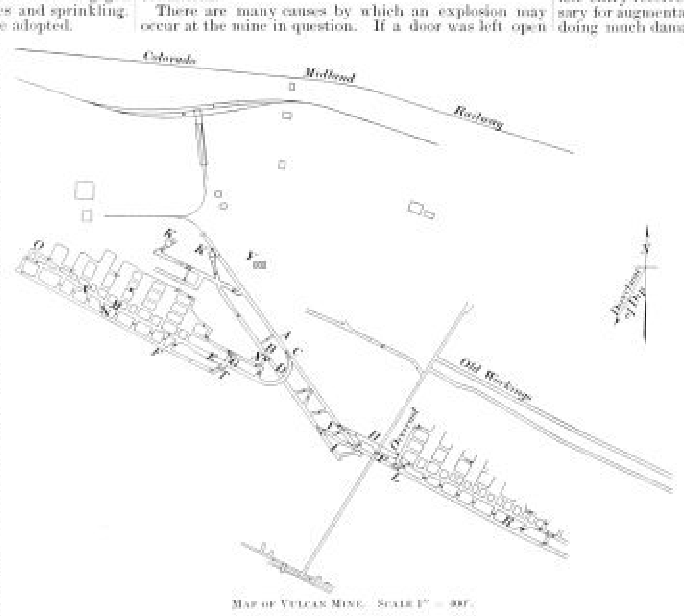
On the 23rd of February I received a communication from Governor McIntire as follows: "I desire to call your attention to the necessity of the most careful and scrutinizing investigation on your part into the causes of the recent terrible disaster at Newcastle so that the responsibility for the awful loss of life may be placed exactly where it belongs. Allow no stone to be left unturned in getting at the exact truth."

I can conscientiously say that I did as the Governor directed me. However, my endeavors were fruitless and I am sorry to say that no definite cause could be found for the disaster. If the exact cause could be found and the blame placed where it belonged we would obtain some satisfaction for the relatives of the ill-fated miners and probably prevent a repetition of a similar accident at this mine or at other mines working under the same conditions.

There are many causes by which an explosion may occur at the mine in question. If a door was left open for a short period an accumulation of gas would be the result and a defective safety lamp would ignite the mixture. Under the same conditions a careless miner might open his lamp and set off the gas, or a blown out shot might cause the disaster; a too heavily charged shot may do the same thing. A sudden outburst of gas may take place and impregnate the ventilating current and form an explosive mixture and the same coming in contact with a naked light or a flame cause the explosion. Other modes could be enumerated by which a disastrous explosion might occur in a gaseous and dusty mine. However, I must form an opinion of the cause from obtainable evidence.

As I previously stated, the mine, in my opinion, was in good and safe condition and there was no accumulation of gas or dust. I will even say more, and that is if the most competent fireboss had examined the mine a minute previous to the explosion he would have proclaimed the mine to be perfectly safe and in a workable condition. By this I mean to say that our present mode of detection of danger is too crude and the danger line is much too high. We are aware that it is impossible to detect less than 2% of fire-damp in the atmosphere of a mine with the common Davy lamp and generally our fire bosses cannot detect less than 4% which in itself is nearly at the explosive point. Experiments prove that even less than 1% is very dangerous in a dusty atmosphere. Some experimenters claim that some kinds of dust, in the absence of any gas, is explosive, others doubt the phenomena. However, all experiments have proved beyond doubt that when both the above ingredients are in the ventilating current (fire-damp being less that 1%) it becomes highly explosive under certain conditions. With these remarks in view, let us consider the conditions existing in the Vulcan mine. Every person that has worked in the mine is well aware that great quantities of gas are constantly transpiring from the strata and that the coal is naturally dusty, and furthermore, explosions have occurred in this field which have been claimed to be due to dust alone. There is no doubt that the dust produced in the Wheeler seam is highly inflammable.

Now the question arises, How could the explosion occur? We admit that gas is emitted freely from the strata in an unknown quantity as to percentage in the air current, but not sufficient to be detected by the Davy lamp, and there must be some small quantity of minute particles of highly inflammable dust in suspension in the air. Such a mixture would be non-explosive in contact with a naked light, but highly explosive if detonated by a blown-out shot, ignition of loose powder, or a small quantity of fire-damp. From the location of the bodies of Mr. Larrigan and Mr. Funke, and the course taken by the force of the explosion, I am of the opinion that the explosion originated in the right or west entry near one of the chutes between No. 7 and No. 10, shown on the map at points *M* and *N*. The timber from this point was evidently forced inwardly and outwardly. The inward force traversed the entry and forced its way to the parallel air course and backward, some of it going up the manways No. 15 and No. 16 at point *O* on map and over the top air course and out through the fan openings. It is evident, however, that in passing through the top air course and rooms, the force was not greatly augmented, because the air course was found in good shape, the only damage done being at the mouth of the fan openings. That the greatest force came through the main right entry is evident by the manner in which the timber was strewn. When the outward force arrived at the air-bridge located across this entry at *D*, a weak point of resistance was found and the force expanded, some of it going up and down the main air-course parallel to the slope and most of it in contact with the return air from the left entry. The force going up and down the main air-course (and intake of the mine) did not get the necessary ingredients to augment its force; it only received a fresh supply of oxygen for the support of combustion. The force on getting in contact with the return air of the left entry received the inflammable ingredients necessary for augmentation and went down the slope without doing much damage to the timber, etc., only one set of which was knocked out, and this at the entrance into the left entry, and five or six more at the double parting. It is evident that the force going down the air-course preceded that going down the slope. This is proven from the fact that the stoppings in the cross-cuts were blown outwardly into the left entry, the most conspicuous being that of the regular stoppings between the left air-course and the double parting at *P*. Evidence of great violence in the force traveling inwardly through the air-course and entry were found, and I am of the opinion that it was aided by explosions of powder which the miners had in readiness for their use. However, we could not find direct evidence to localize this any more than that the augmentation of the explosion was very great. At the face of the left air-course a car was found, the ends and sides of which were smashed into kindling wood. The bodies found near the face of the main entry were badly mutilated. The forces coming in through the air-course and main entry met at about No. 12, or at point *R*. This, I think, caused great commotion at this point. After expending all the elements of energy the reaction took place and volumes of smoke came out leisurely through all the openings.



MAP OF VULCAN MINE. SCALE 1'' = 400'.

I have as yet omitted to explain how I think the explosion originated. Thomas Larrigan was supposed to examine every place in the mine previous to firing any shots. He was also supposed to fire the shots. Now, I have formed an opinion that one of the chutes in the right entry had become blocked, and in order to remove the stoppage it was necessary to put in a little powder to start the same, and in so doing the explosion occurred. I have no doubt that Mr. Larrigan examined the condition of the place and used his judgment as to the amount of powder, etc.; but there may have been a small quantity of fire-damp existing in the chute at a point he could not reach or observe. It is probable that any practical man would have done the same thing he did. Now, assuming the above statement to be correct, I will endeavor to explain how the explosion originated. The explosive used may have been placed on the lump of coal blocking the chute and covered with a small quantity of dust or slack; from this the flame would elongate and set off the small quantity of gas that could not be observed and an explosion on a small scale would be the result, and the compression of the air current due to this would cause the air itself to become explosive, and the agency causing the compression would also ignite the mixture.

On Sunday, March 15th, after all the bodies were recovered, we held a conference in the mine consisting of the following practical miners, all of whom had been aiding in the explorations: M. M. Walsh, mining boss, Blossburg, N. M.; Robert O'Neill, mining boss, Starkville, Colo.; Ed Flynn, superintendent, Rockvale, Colo.; Joseph Fletcher, coal mine inspector, A., T. & S. F.; Robert Herricke, local superintendent; John P. Thomas, mining boss, Rockvale, Colo.; Harry John, fire boss, Rockvale, Colo.; Charles Grant, fire boss, Rockvale, Colo.; George Ward, local fire boss, Rockvale, Colo.; Humphrey Davies, fire boss at Newcastle mine.

Others were invited, but for some reason did not attend. The object of this conference was to try and localize the point of origin of the explosion, but no definite conclusion could be arrived at.

In examining the effect of the explosion, the reason why there were so many different opinions is made manifest. I will here state that my opinion is based upon the most plausible cause from which it could have occurred. Many are under the impression that it originated from a blown-out shot because it was about firing time when the explosion occurred, but there is no evidence of any shots having been fired except the one fired by Mr. Larrigan in a dog-hole near the face of the left entry. There were several lamp keys found on the bodies, but not a single open lamp. Matches were found on some of the bodies, but there was no evidence found that anybody was lighting a lamp or attempting to smoke. On taking everything into consideration I am of the opinion that the principal ingredients causing the disaster were dust and gas, but that the known line of danger was not perceptible, and that the cause or origin is only a matter of supposition at best, and will remain a mystery like many other similar disasters.

The effect of the explosion was so violent that I am of the opinion that every man in the mine died instantly and that not one of them breathed any after-damp. Some or the bodies were burned, but I do not think the burning effects would have resulted in death. The fans located on the surface at *K K* were blown to pieces and the three openings shown on the map were nearly closed. This was caused by the timbers being blown out and the dirt they sustained caving in. Every wooden stopping and door in the mine was broken except one door in the inside haulage cross-cut in the right entry at *S*. This was forced open and nearly off its hinges; the others were shattered like matchwood. Two stone stoppings were blown out, one between the slope and air-course opposite the left entry at *V*, and one between the left main air-course and left main entry on the double parting at *P*. Several stone stoppings between the slope and its parallel air-course stood the severe test and thus aided us greatly in getting air through the workings after the explosion. On the curve coming out of the right entry nearly all the timbor was blown out. Many sets in the inside withstood the violence, not a set being out on the double parting. The slope timbers were undisturbed with the exception of six sets at the mouth and one near the entrance to the left entry. Inside of the parting on the left entry and air-course the force was most violent. Nearly every set of timber was blown out and heavy caves of coal had fallen, which greatly retarded the explorations.

There are some peculiarities in connection with this explosion which caused different opinions as to the ingredients which were predominant in the explosive mixture. It is the opinion of scientists and practical men that if fire-damp predominates at the time of the explosion intense heat is developed, and that traces of this will be left on all material susceptible to fire, and if the dust in suspension in the air current predominates, that caking or coking results will be found in abundance after the explosion. In this case we have no traces of fire on any susceptible material, such as timber, canvas, or brattice cloth. The steam pipes were covered with hay and then wrapped with shredded canvas, which was as dry as tinder and strewn all over, but even on this we could find no trace of fire, and with a very diligent search by myself and others we failed to find any trace of coked dust as a residue. Still, some of the bodies were burned in proximity to some of the susceptible material mentioned above. Such a statement may appear to be absurd, nevertheless it is true. The only way I can account for these phenomena is that the elements in the explosive were not productive of a long-extended flame, but intense heat was created and the explosion passed through all the workings with lightning rapidity. That there was intense heat I have no doubt, but it must have been of very short duration. Some of the bodies were denuded and horribly mutilated, decapitated and disemboweled. Nearly all of them had to be identified by their wearing apparel or other appurtenances.

On the body of one of the men a watch was found that had evidently stopped instantly, owing to the violence of the explosion, at 11:27 a. m., so we concluded this to be the correct time of the explosion. I was notified of the explosion through the courtesy of Mr J. A. Kebler, general manager of the Colorado Fuel and Iron Co., at 12:45 p. m., and at 2:05 p. m. received an official telegram from Mr. Herricke, the local superintendent.

In accordance with section 8, Coal Mines Act, myself and my deputy boarded the first available train and on board the cars we met Mr. Kebler and Mr. Willard, general superintendent of the coal agency of the A. T. & S. F., also Mr. Coughlin and Mr. McGourty, both of whom had sons in the ill-fated mine. We arrived at the scene of the disaster about 12:30 p. m. on the following day. At this time some bodies had been brought out of the mine and a fan was in operation. Great credit is due Mr. Herricke, local superintendent, Mr. Paul Blount, superintendent of the Newcastle mine, and his mechanic, Mr. Jas. Buchanan, for the expedition with which they erected this fan, which had to be transported from the Consolidated mine, engine erected, fan cased, etc., it being in operation in less than twenty-four hours after the explosion. Mr. Choate, the division superintendent of the Rio Grande, sent some carpenters to aid in its construction.

At this time all hopes of rescuing any of the miners alive had been given up and we waited for the fan to clear out the foul atmosphere in the mine. During this time we held a conference as to how we were to proceed. In this conference were Mr. Kebler, Mr. Blount, Mr. Herricke and myself, and we decided to enter the mine at 2:40 p. m. and that from inside observations we could decide on the mode of action. At the appointed time Mr. Herricke, Mr. Kebler, George Ward, John Evans, Humphrey Davies and myself entered the mine. George Ward, John Evans and Humphrey Davies were the heroes of the party. The first obstruction we met was the dilapidated air-bridge across the right entry at *D*. Ward and Davies passed over the obstruction, and penetrated into the right entry about 300 feet. On returning they reported that the narrow entry round the curve was in bad shape, but that the double parting was in good shape and that they had not seen any fire-damp, also that there was a good current of air passing. Evans, owing to an accident (a nail penetrating his foot), returned to the surface, and the remaining five in the party went down the slope as far as the entrance to the left entry. Here we found a set of timber blown out, and about 30' in the left entry fire-damp was found. We then concluded to return to the surface and take immediate steps to remove the fire-damp from the left entry and at the same time have the air-bridge over the right entry at *D*, temporarily erected.

We had all the voluntary help we needed at this time and the first work done was the placing of a temporary stopping on the crop entry; this carried all the air produced by the fan, about 40,000 cubic feet per minute, down to the air-bridge, and returned it through the slope. Then the air-bridge proposition was considered and from the amount of work necessary to erect it and the greater number of bodies being in the left entry, it was decided to build a stopping on the entry and have the air down to the left entry as soon as possible.

During this preliminary work, Mr. Kebler acted as consulting engineer and he coincided with our views and the men under his management were the volunteers. On Wednesday night, February 19th, about midnight, Mr. Joe. Fletcher, Sante Fe mine inspector, and Dan. McLaughlin, superintendent of Starkville, arrived with a reinforcement of men, twenty in number, and some of them were immediately put to work building stoppings, etc. As yet there had been no system adopted as to the hours of work. On Thursday night, February 20th, Mr. C. J. Devlin, general manager of the A. T. & S. F. coal properties, arrived on the scene. All the details then known as to the condition of the mine and mode of procedure were stated to him, and he was satisfied that everything had been done to the best advantage under the circumstances, and that the hours of labor were too long and that in order to expedite the exploration it would be necessary to systematize the work. On the 22nd of Febeuary the following notice appeared, signed by Mr. Devlin and approved by me:

NOTICE TO MINERS.

"In order to push the work with the greatest speed the following rules will govern:

"1. Shift Bosses will each work six hours. Pay in accordance therewith.

"2. Others in mine will work three hours each.

"3. Pay for three hour shifts $2.75. Pay for shift bosses, per shift, $3.00. Each man is requested to do his utmost so as to get the bodies out in the shortest possible time."

Previous to this notice the men had been working six hours at a shift and some dissatisfaction was exhibited, but not enough to delay the exploration work. Messrs. Fletcher, Herricke and myself selected eight shift bosses who were men of practical experience and acquainted with the mode of working, etc. They were George Ward, Henry John, John Evans, J. P. Thomas, Joseph Griffiths, William Doyle, Humphrey Davies and J. W. Smart. Two of these men were in charge of the work every six hours; their duty was to direct the men what to do and to watch the fire damp that we knew existed in the mine. When this system was enforced we found it difficult to obtain men for the work and many of the miners had to work six hours in order to keep the work going. If it had not been for the Colorado Fuel and Iron Co. closing down their mine it would have been impossible to get the required number of men necessary to carry on the work. On the 23d of February Mr. Ed. Flynn arrived with twenty-eight men from Rockvale. On the 25th, Mr. Robert O'Neill, of Starkville, arrived with five men and M. M. Walsh, of Blossburg, N. M., brought seventeen men with him on the same date. We were now well reinforced and everything was done that was necessary to expedite the work. Mr. Devlin left after being there a few days and entrusted Mr. Joseph Fletcher with the management of the exploration with the instructions that he was not to consider expense, but to get the bodies out with all possible haste.

After removing some of the gas in the left entry we were able to explore the double parting up to the haulage cross-cut and did not find much obstruction, only a few sets of timbers being out. At the end of the parting we found that a great quantity of coal had fallen and had to be removed. The slope was cleared and the cars were put in motion to remove the fallen coal. The gas in the two parallel entries was removed by placing a temporary stopping in the cross-cuts as we advanced and all the miners were taken into the intake air course until it was diluted. On the night of the 27th of February the main left entry was all cleaned up and examined. During this time work was also carried on in the back entry, but from the fact that there was more coal to handle, etc., it took a few more days to get cleaned up, but some of the explorers went over the fallen coal and found the body of Robert Steiger, track-layer, in the face of the back entry. During the time of cleaning up the entries we knew that the man-ways, cross-cuts between rooms, and some faces were full of inflammable gas and this was constantly watched by one of the shift bosses in charge. Preparations for a greater supply of air had been made by repairing and erecting the double Murphy fan, and at 12:30 a. m., March 1st the fan was started and the air current turned up the inside rooms. While doing this a three-hour shift was laid off and only five bosses allowed to be in the mine. The quantity of air had now been increased at the outlet from 38,000 cu. ft. to 50,000 cu. ft. per minute, but from the fact that all the stoppings were leaking, the quantity playing on the gas did not exceed 28,000 cu. ft. In removing the great quantity of gas from the rooms great precaution was used in keeping all lights from the return air and also from the mouth of the slope. By the morning of March 5th all the standing gas had been removed from the left side of the workings and all places thoroughly examined.

On Friday morning, March 6th, operations were started on the right entry. While the greatest force of men were working on the left entry, preparations were made for getting into the right in order to be able to split the air current. By doing this the quantity of air in the left entry was greatly reduced. However, enough air was kept there to dilute all the gas that was given off. It is evident that some air had been going through nearly all the workings in the right entry or we would have found more standing gas than we did. The only place where standing gas was found was at the top slate air course and at the top of No. 8 room at O. We found things in a much better condition here than we expected, the worst caved place being around the curve outside of the double parting. On the double parting an accumulation of water had taken place and to remove this it was necessary to have a pump located near it. A pump was already on the ground and in less than forty-eight hours the water was pumped out and the cleaning up of the entry resumed. On Sunday morning, March 15th, the body of Robert Allier was brought to the surface and this completed the number as reported on the official list. During the exploration work some of the shift bosses resigned and other men equally as good were appointed to fill the vacancies; they were Messrs. Thomas Neeson, James Daniels, Charles Grant and George Bunn.

Great credit is due Messrs. Jones, Deputy Inspector, Herricke, Fletcher, McLaughlin, Flynn, O'Neill and Walsh for the general overseeing of the work and to the shift bosses for their diligence. However, the greatest credit is due the miners who were actually doing the work.

To give the details of the exploration would cause this article to be too voluminous. Suffice to say that the work was very perilous and the surroundings unpleasant. We were fortunate not to have any serious accident to any of the explorers.

Before resuming work at the mine with the full force of men I recommended Mr. Herricke, local superintendent, to make the following changes:

Have rock stoppings built in all cross cuts between all parallel entries, and in placing doors on the gangways have them packed or tightened with cement, lime mortar, or some other material not liable to fire. Have a fan or fans capable of producing, say 60,000 cu. ft. of air per minute, to be distributed to the right and left entries in separate currents and in proportion to requirements. Have the air distributed through the working places the same as it was previous to the explosion. I recommended an exhaust fan as giving better results than a compressive or blower fan. In connection with the use of safety lamps I am of the opinion that the Mueseler lamp now in use is as good as any. In relighting the lamps in the mines I recommended that no man be allowed to have a key except the fire boss and that all lamps be opened in the intake air course. I also recommended that the watering system be kept in good order and in shape to sprinkle all the working places, that such timbering as was necessary to put the entries in good order be immediately set, and to allow no blasting except at stated periods when all the men except those actually needed to fire the shots are out of the mines. I also recommended an electric bell or gong in the steam engine house for the purpose of signaling. In case they continued to use steam for pumping purposes, I recommended that the present steam pipe covering be removed, and, if the pipes must be covered to keep down condensation, to have them covered with an asbestos composition. I also suggested the use of compressed air for pumping purposes. I requested Mr. Herricke when ready to resume work and the aforesaid improvements were made to notify me so that I might examine the general condition of the mine.

Our present mode of the detection of gas is too crude and as there is now on the market a reliable and very sensitive mechanical instrument by which small percentages of gas in air may be detected (namely Shaw's Gas Testing Machine) I think the mine inspector should possess one so as to enable him to find the percentage of gas in the air currents of our gaseous mines and have the air currents regulated accordingly. Furthermore, every superintendent of a gaseous mine should have one of these machines so that daily tests can be made of the return air currents and a record thereof be kept in the local office.

In regard to the use of explosives I would recommend the following rules for use in dusty and gaseous mines.

First.—The powder should be of that brand known as the least productive of flame.

Second.—All holes should be drilled under the supervision of a competent person.

Third.—All holes should be charged, tamped and fired by men selected for that purpose. The charge should be in accordance with the burden of the hole, etc., and the tamping should be of material not productive of flame. Before firing the surroundings should be thoroughly examined as to the presence of dust and gas.

Fourth.—No shots to be fired or powder detonated anywhere in the mine except at a specified time and all men to be out of the mine except those actually required for the purpose of firing.

Ruberoid Roofing.

Our attention was recently called to the roofing used at one of the larger anthracite collieries on the breaker, engine house, boiler house and other colliery buildings, by an official of the colliery. It was made from a heavy wool felt thoroughly saturated with a water and acid proof composition. It was strong and very durable, would not run at any temperature, contained no tar, and was simple and economical to lay. Long use had proven it absolutely impervious to moisture, and proof against steam and gases. On the boiler house, where it was subjected to the action of heat, steam and the gases generated from the combustion of coal, it gave remarkably satisfactory results. Besides it makes a fire-proof roof. It is not expensive, and the ease with which it is laid makes it an ideal roofing for mine and mill structures. It is manufactured by The Standard Paint Co. of No. 2 Liberty street, New York, whose reputation as the manufacturers of the well-known "P. & B." paint is sufficient guarantee of its excellence, even if practical use had not demonstrated its superior merits.

METAL MINING.

ARTIFICIAL MEANS OF VENTILATION.

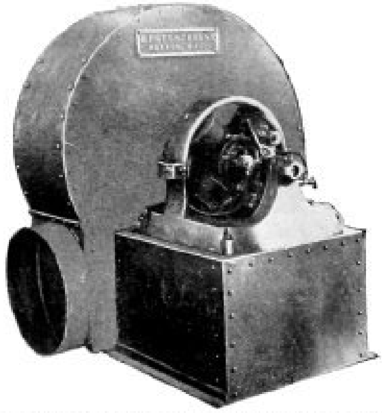
American and Foreign Practice Compared—Fans and Their Different Varieties—Air Pipes for Blowers and Fans—Force and Exhaust Systems Compared.

Written for THE COLLIERY ENGINEER AND METAL MINER by Albert Williams, Jr., E. M.

(Continued from May Number.)

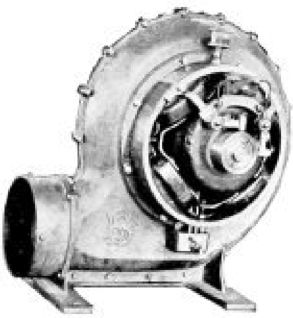
FANS.

American practice in the mechanical ventilation of metal mines varies widely from English and Continental methods. Abroad they adhere to the large, low-pressure centrifugal fans, of which the Guibal is a well-known type. These large fans are well suited to collieries, as they handle great volumes of air at low pressure. They are usually run as exhausts and without



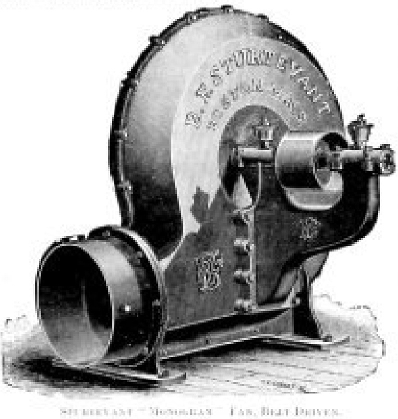
STURTEVANT EXHAUST FAN WITH SLOW MOTION ELECTRIC MOTOR (GENERAL ELECTRIC CO.)

underground air pipes, being placed at the side of a shaft mouth, from which they suck out the air. Some fans of this class are as much as 50 feet in diameter, and the medium sizes would here be regarded as clumsy and



STURTEVANT FAN.

unnecessarily cumbrous. They are run at relatively low speeds. A few are seen in American metal mines. Preference is, however, given to the small, high-speed fans of greater relative power and with better mechanical construction and efficiency.



STURTEVANT "MONOGRAM" FAN, BELT DRIVEN.

Fans are much more frequently used than blowers, and some of them develop pressures or vacua comparable with blowers, so that they are effective for the longest distances reached by mining.

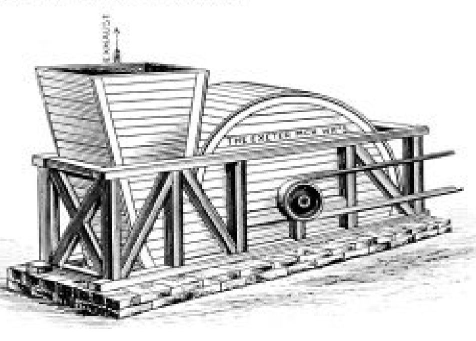
As to mode of action, there are two main divisions of fans—centrifugal and propeller. The former class is much the more important.

A simple apparatus like the paddle wheel of a side-wheel steamboat, on being rapidly rotated, would produce a tangential movement of the air by centrifugal force, the outgoing air being replaced by air drawn in at the center. This principle is taken advantage of by a multitude of devices giving improved efficiency over that obtained by merely beating the air with plain flat radial buckets or floats (as in the paddle-wheel, or blades or vanes as they are called in fans). The propeller class act on the principle of the small ventilators used in buildings, are run open, and drive the air through them.

Mentioning first some of the large centrifugal fans:

The Guibal fan.—In this fan the blades are flat or slightly curved at the tips. They are not set radially, but are inclined backward. There may be 8 or 10 blades. The fan is cased in. Other features are regulating shutters and an expanding exhaust stack which reduces the velocity of the air and consequently the back pressure of the atmosphere. There are many modifications of the original Guibal.

The Capell fan of equal power is smaller than the Guibal and is run at higher speed. It has two concentric shells besides the outer casing. In each are curved vanes, convex side forward. Air enters the inner shell, is forced out through ports into the second outer



EXETER FAN, SHOWING CASING.

shell where it strikes the concave faces of the outer blades, the idea being to return part of the impulse first received and also to discharge the air at low velocity. It has an expanding exhaust flue, and is used as a suction fan.

The Waddle fan is run without a casing. It is narrow and of large diameter. One side is closed; the other has a central opening. It is an exhaust fan.

The Schiele fan has curved blades, and its main peculiarity is that it is set close to the casing at one point only. It is much smaller than the Waddle and the Guibal and is run at a speed comparable with the American fans.

There are many other fans of European invention, but the Guibal and its modifications is probably the most frequently used.

Passing now to American fans.

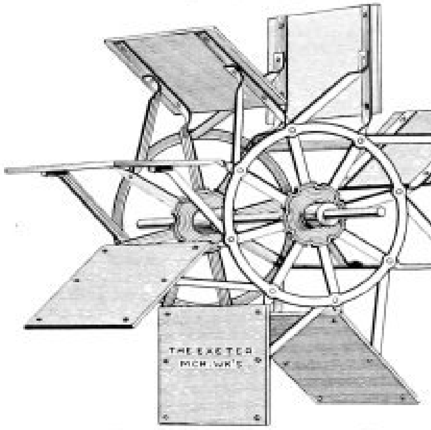
The Sturtevant fan.—This is a strongly built (of steel) compact machine, capable of being run at very high speeds (up to 2,000 revolutions or over per minute), and therefore of large capacity in proportion to its size. It is used to furnish air at high pressure for iron furnaces and for forcing air long distances, as in pneumatic tube delivery systems, and consequently is fitted to meet extreme requirements in large mines, using smaller air pipes, if necessary, than usual. When used at high pressure it is called a "blower." It is made as a forcing fan and also as an exhauster; right-hand or left-hand power; with horizontal or upright discharge; and in ten sizes. It is either driven by belt (in

CHAMPION FAN WHEEL.

which case a large pulley should be used on the counter-shaft, to obtain high speed of fan without too high driving speed), or by electric motor on the fan itself.

A special form of Sturtevant fan, known as the "Monogram," is designed for forcing or exhausting large volumes of air, as in mine use. The castings are very heavy and strong.

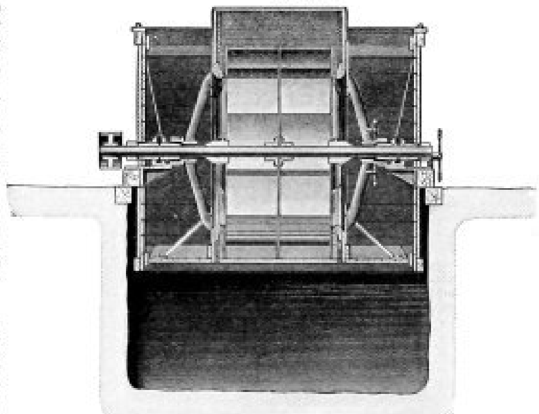
Exeter Fans.—Among other fans, the Exeter Machine Works make exhaust mine fans, the construction of which is clearly shown in the cut. These fans are of rather large size, one style being 5 to 15 feet in diameter,



EXETER FAN, SHOWING ARRANGEMENT OF BLADES.

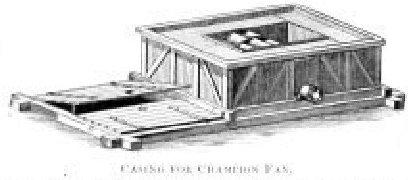
and another 15 to 30 feet in diameter.

The Champion Fan.—This is really two fans joined together by a common center ring, which is a solid plate. The outer rings have unusually large openings. The blades have a curvature designed to propel the air with minimum resistance. The fan is used either to blow air into the mine, or as an exhauster. There is an inner casing (called a hood) and attendant diaphragm which are hung on bearings, so that by revolving the hood around the fan without stopping the latter, the current may be changed at will from blowing to exhausting. The Champion is used without air pipes. It is placed at the side of an air shaft, with which it is connected by an airway, and at a tunnel mine it is located at the side of the tunnel mouth, connecting with the tunnel by a similar side airway. The fans are made in six sizes, running from 4 to 14 feet in diameter.



CHAMPION FAN, CROSS-SECTION.

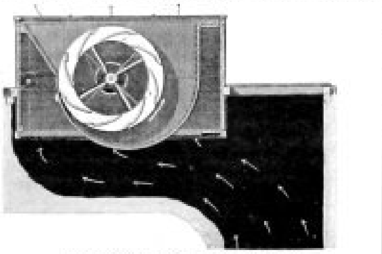
The Smith Fan.—The essential feature of this fan (or blower, as it is usually called) is the double discharge. To secure this the case is extended on the rear end and a second outlet is provided, which is led around and under the first one, to the front, where the two outlets unite in one discharge. The theory of this construction is that a vane of a fan wheel becomes loaded with air



CASING FOR CHAMPION FAN.

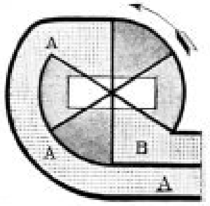
long before it completes a revolution (at one-third revolution, it is claimed), which air cannot be discharged until carried around, against the back pressure, till it reaches the outlet.

The same result (as effected by the double outlet) cannot, it is argued, be obtained by merely doubling the area of a single outlet, for the effective peripheral distance of the blades is limited to the space where the tangential action exists. A blade cannot discharge air back of it, nor beyond the point where it crosses the line



CHAMPION FAN, LONGITUDINAL SECTION.

of flow. The double discharge gives a large capacity for a given area of fan, or in other words, a smaller fan can be used to match a given outlet. As forcing fans (blowers) these give large volumes of air in proportion to size. There are manifest advantages in reducing the size of a fan. Exhausters are built on a similar principle.



THE SMITH DOUBLE DISCHARGE FAN.

The Davidson Fan.—This is an open disc-wheel fan of peculiar construction. The blades are shaped with the design of cutting through the air and forcing it off, instead of carrying it along with the wheel. The blades are not perpendicular to the axis of the shaft at the center, and have a feeding surface the whole length of the blade from the periphery to the center delivery. Each surface of the blades is both concave and convex. This fan gives pressure as well as volume, and though not specially made for mine work has been used in ventilating long railway tunnels, one 15 ft. fan moving 160,000 cubic feet of air per minute through a 3,800 ft. tunnel, and another 20 ft. diameter (said to be the largest disc-wheel fan ever made), moving 250,000 to 300,000 cubic feet per minute through a 4,900 ft. tunnel.

As to disc-wheel (propeller) fans in general, it may be said that there are situations in mining where they would be useful. For example, where electric plant is already installed for other purposes, such fans could be placed underground where most needed, and readily moved from place to place as required. Even small hand-power fans of this class would be available under certain conditions, especially in mines having no power plant. Or, placed horizontally over an air shaft not giving satisfactory ventilation by natural draft, disc-wheels driven by wire rope from the hoisting works, or by

DAVIDSON DISC-WHEEL FAN.

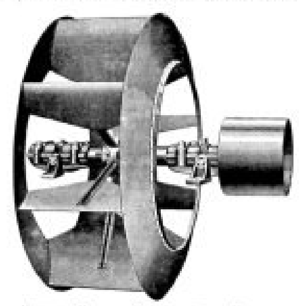
electric motor, would serve a useful purpose. It might also be possible to reduce the section of an air shaft (that is, a shaft intended solely for ventilation, and not as an air shaft, and for other purposes also), to the smallest dimensions that could be conveniently cut out, if a fan were added.

The Buffalo Fans.—As the Buffalo Forge Co. makes such a variety of fans, usually to order for special requirements, it is impossible to give a general description of the machines. For mine ventilation the specialties are exhausters of all sizes in wood or brick housings and and "volume blowers" (fans) with electric motor directly attached, made in many sizes.

POWER.

Almost all the makes of blowers and fans are built in a variety of ways as regards the application of power, and the user has a wide choice. It is of course cheaper to belt on to some other machinery, and if there are Cornish pumping engines it is pretty certain that they are constantly running. Artificial ventilation, if required at all, should be constant, not intermittent. Pumping engines and (usually) stamp mill engines run pretty steadily, but the hoisting plant may not. Hence, if there is urgent demand for machine ventilation, and that on a large scale, it is better to have the blowers or fans driven by their own engines or motors, and for this purpose the arrangement should be self-contained; that is, the engine should be on the same bed plate and the electric motor directly connected.

As to the kind of power best suited to driving high-speed fans or blowers, electricity is undoubtedly the best; and what is termed a "slow speed" motor is now available, which can be attached to the blower or fan



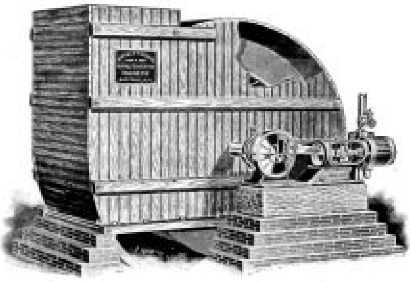
BUFFALO FAN FOR WOOD OR BRICK HOUSING.

shaft direct. But if electric power is not used at the mine otherwise, then special high speed engines, designed for the purpose, can be used.

There are many other forms of American made fans which might be used in ventilating mines.

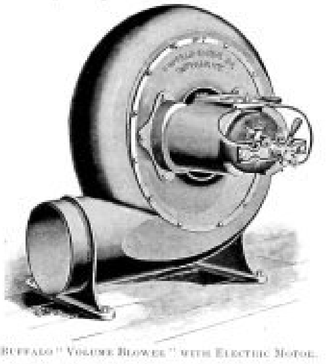
AIR PIPES FOR BLOWERS AND FANS.

Ventilating pipes should always be as tight as possible, and when air is used under strong pressure, as with blowers and high speed fans, the pipes should be per-



BUFFALO EXHAUST FAN IN WOOD HOUSING.

fectly air-tight. Small leakages are not allowable, for as much power is used upon every cubic foot of air lost as upon the same volume utilized. The higher the pressure, the greater the leakage through holes of the same area. Wrought iron pipes are commonly used, while steel is coming into use also. The best styles are the spiral riveted or the welded seamless, when the air is at considerable pressure. For low pressures a cheaper style will answer. To protect against rusting, in wet mines, the pipes may be either galvanized (and regalvanized after riveting) or coated with coal tar or asphalt applied at high temperature.



BUFFALO "VOLUME BLOWER" WITH ELECTRIC MOTOR.

FORCE AND EXHAUST SYSTEMS COMPARED.

In a colliery the essential thing is to draw off the gases escaping from the coal. Hence, if the gas emission comes mainly from one or a limited number of points it may be better to suck it out at once through exhaust pipes, rather than diffuse it through the mine.

This is in addition to the necessity of supplying fresh air to the men and animals (if any). But in metal mines the conditions are different. Elaborate systems of brattices, sollars, air doors, etc., are not often needed. All that is required is that all the workings through which men pass should be fairly ventilated, and that particular attention should be given to the actual working places, the most important being the upper parts of stopes and upraises, the headings of drifts and tunnels, and (when sinking) the bottoms of shafts and winzes. It would seem more logical to send the fresh air from the surface direct to the spots most needing it, this air driving out the foul air. As for the general ventilation of all the workings, taken as a whole, there is little to choose between the exhaust and plenum or force systems, and for the reason given the force system is usually preferred. Still the direction of natural draft, however slight it may be, must not be opposed, and the whole arrangement of the ventilating pipes made accordingly. In very deep and hot mines, if several levels are being worked simultaneously, special attention should be given to the lowest and hottest one.

It would be better that the hoisting shaft should be a down-cast and the air shaft an up-cast, if the mine is opened on this plan; yet this consideration is not so important as that the working faces be kept wholesome.

Most of the blowers and fans act equally well as forcers or exhausters, but some are made for one purpose only, and when a fan is ordered for suction it should be specified that an "exhaust" fan is required.

(To be Continued.)

An Automatic Mine Door.

No matter how good a ventilating plant is used at a mine, it is never positive in its results unless the doors in the air passages are either closed or open as the case may require. *Open* doors are seldom used, except at such points where it is desirable to temporarily cut off the air current from some section of the workings. *Closed* doors are necessary in every well ventilated mine, and the efficiency of the ventilation depends very largely on their being *kept closed* except when trips or workmen are passing through them. This necessity, has in the past required the employment of door boys, or trappers, whose duty is to see that the doors are kept closed as much as possible. Where no door boys are employed the rule is "leave every door you pass through just as you found it." This rule is frequently violated, and as a result trouble with the ventilation and sometimes serious accidents are the results.

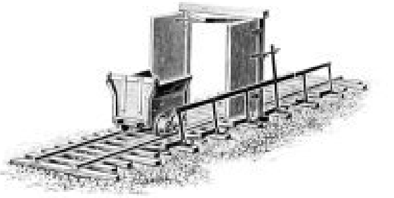
An automatic mine door that is positive in its action, simple in construction, and one that does away entirely with door boys, and the trouble of doors left open through neglect, is desirable at all mines. Such a door is illustrated herewith.

This door is manufactured by the Standard Mine Door Co. of Glouster, Ohio, and it is either put in on royalty or sold outright. Its construction is remarkably simple, and it works equally well on either straight or curved roads. It is very durable and if at any time repairs are needed, they can be made by the ordinary mine blacksmith. This feature is a valuable one, for if a mine owner purchases one of these doors he can have it repaired whenever necessary by his own blacksmith, and the one purchased will last during the life of the mine. The track bar is so arranged that the trip of cars will either open the door or stop before reaching it. It is impossible for a car to ride the track bar. The door can be adjusted to open slowly or fast, and to accommodate trips of any number of cars desired. The door and its operating mechanism are so arranged that there is no danger of coal falling off the car breaking any part.

What one door saves in trapper's wages will more than pay for it in the first year.

This door is not placed on the market as an untried appliance. There are a number of them in use giving excellent satisfaction. We have seen several letters from users of them, which heartily commend them.

Mr. D. S. Williams, superintendent of the Chicago and Central Ohio Coal Co., Jacksonville, Ohio, writes



THE STANDARD AUTOMATIC MINE DOOR.

under date of January 28, 1896, as follows: "The Standard Automatic Door, placed in our mine No. 4, is doing excellent work. It is a perfect success. We cheerfully recommend it to all coal companies as a good thing."

Mr. J. A. Hopkins, Supt. mine No. 10, of the Sunday Creek Coal Co., Derthick, Ohio, writes under date of Dec. 17, 1895, as follows: "The two Standard automatic trap doors, placed in this mine some time ago, are giving excellent satisfaction. While the place we are using them is a severe test, they are giving us better ventilation and saving money. No superintendent will make a mistake by having them put in."

Mr. Lewis Jones, Supt. of Phenix mine No. 2, of the Phenix Coal Co., Glouster, Ohio, writes under date of Dec. 17, 1895, as follows: "The two Standard automatic trap doors placed in mine No. 2, some time since have been given a very fair trial, and so far they have worked entirely satisfactory, performing all claims made for them."

"Jeffrey Labor Saving Appliances" is the suggestive title of a handsomely illustrated pamphlet recently issued by the Jeffrey M'f'g Co., of Columbus, Ohio. It illustrates and describes the various styles of Jeffrey handling and conveying machinery, and successful Jeffrey electric mining machinery.

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....AND.....

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CERTIFICATED MINE FOREMEN.

A RATIONAL law providing for the examination and certification of mine foremen, and for the appointment of mine inspectors by competitive examination, has been found advantageous in every coal mining state that has such a law.

There is no good reason for opposition to such a law on the part of either miners or mine owners. A mine foreman who is naturally of good executive ability, energetic and temperate in habits is not injured by the acquisition of technical knowledge. On the contrary, he is improved. He can, by thoroughly understanding the laws governing the flow of air through mines, distribute his available air current to better advantage, and can also frequently increase its efficiency. By a knowledge of the forces of nature and of the sciences connected with mining he can produce coal cheaper and can increase the safety of both the miners and the property entrusted to his care.

Certificates of competency for mine foremen do not mean fewer practical men, they mean practical men with broader views, men who are equipped not only with their own experience, but also with the experiences of others.

We do not claim that every man who secures a certificate of competency as a mine foreman will be a success. His certificate merely shows that he has the technical knowledge necessary to keep a mine safe and to get out coal in the best manner. Whether he has the executive ability to handle men must be determined by actual trial just as it must be with non-certificated men.

In fact, the case may be stated briefly as follows:—

Without certificates of competency neither mine owners nor miners can be sure that a foreman has either mining knowledge or executive ability, unless he has been a foreman for years.

With certificates of competency issued by a reliable board of examiners, the question of mining knowledge is settled, and it is safe to assume that men intelligent enough to prepare themselves for an examination, are more likely to know how to handle men than those who have not enough ambition to increase their knowledge on mining subjects.

As for the selection of mine inspectors by competitive examination, we will only give the following reasons for its superiority over other methods:—

First.—It insures the selection of a competent man.

Second.—It removes the office from partisan politics.

Third.—The man appointed on merit is under obligations to neither miners nor operators, and can therefore fulfill his duties in an impartial manner.

THE DETERMINATION OF THE COKING QUALITY OF A COAL.

AS is well known, the chemical analysis of a coal is no guide as to its coking quality, and the question as to whether a coal will produce good coke has only been satisfactorily proved in the past by actual trial. The chemical analysis, which gives the percentages of fixed carbon and volatile matters, will furnish an idea of the nature of the coke to be obtained, but it does not determine whether the coal will coke or not.

M. Louis Campredon, in a paper read before the Academy of Sciences in Paris, in December last, describes a method for obtaining the binding power of coal which he has used at the Vignac Works for three years with signal success. To show the lack of relation between the composition of the coal and its binding quality, Mr. Campredon furnished the following table of analyses:—

	Volatile matters, per ct.	Ashes, per ct.	Fixed carbon, per ct.	Binding power.
1. Through coal from Aberdare, Merthyr (South Wales)	10.90	6.20	82.90	0
2. Through coal from Newcastle	34.25	10.80	54.95	2
3. Through coal from Scotland	34.72	8.35	56.93	4
4. Small coking coal from Cardiff	19.80	7.70	72.50	6
5. Through coal from Lens (Pas de Calais)	27.20	8.70	64.10	15
5B. No. 5 oxidized by heating at 100° during one year	28.12	8.55	63.33	0
6. Small coking coal from Newcastle	27.83	8.75	63.42	14
7. Small coking coal from Newcastle	29.50	8.50	62.00	17
8. Pitch from Beckton (London)	44.82	0.60	54.58	20

As will be seen from the table, he has taken 20 as the binding power of pitch, and he makes that of a coal giving powdered coke 0. The most binding coal he had found, up to the date of the preparation of his paper, had a binding power of 17. M. Campredon's method is similar to that used in estimating the binding power of cement. The principle involved is the mixing of the coal with an inert substance, and the carbonization of the coal in a closed vessel. The amount of the inert substance the coke produced contains measures the binding power.

The method of operation as given by M. Campredon, is as follows:

Pulverize the coal so that it will pass through a sieve of 2,580 meshes per square inch. As an inert body take some siliceous sand, (sea, river, or quarry sand), of a fine and uniform grain, which will pass through a sieve of 645 meshes per square inch, but over a sieve of 2,580 meshes per square inch.

To a constant weight of powdered coal (one gramme, for instance) mix variable weights of sand, and heat the mixture to a red heat in small porcelain crucibles, so as to carbonize the coal. After cooling, either a powder without consistence or a more or less hard dross will be found. Then determine the maximum weight of sand the coal can agglomerate in forming a solid dross. Assuming the weight of the coal used as a unit, the binding power is given by the weight of the agglomerated sand.

A little coke indicates a small binding coal, and a swollen and bright, or a hard and compact coke shows a coal having the binding properties necessary for coke making.

UNDERGROUND TEMPERATURES.

THE question of the rate of increase in temperature from the surface of the earth downward has long been one on which prominent authorities differ, and no law on the increase of temperature expressed in arithmetical progression has ever been found applicable in a universal sense.

Among the scientists who have recently given this subject considerable thought is M. Joseph Libert, who records observations made at Produits colliery, Flenu, Belgium. These observations, owing to the depth of the shaft, have been carried to a depth of 3,772 feet. Taking 82 feet as the depth at which atmospheric variations of temperature cease to have any influence, it was calculated that the rate of increase of temperature given by the tests at Flenu was 1 degree Fahrenheit for 53.97 feet of vertical depth. This result agrees closely with that obtained some years ago by M. Cornet in the same district, his rate of increase being 1 degree Fahrenheit for 54 feet, only, however, for depths up to 1,679 feet.

Prof. Prestwich's mean, derived from English and Belgian mines, was 1 degree Fahrenheit for 49.5 feet. M. Libert, does not, however, think that the law of increase of temperature can be correctly expressed as arithmetical progression, but that the rate of increase is greater at greater depths. Taking the results obtained at Flenu with those obtained at the Grand-Buisson colliery in the same field, he concludes that the rate of increase down to depths of 2,263 feet is 1 degree Fahrenheit for 65 or 69 feet, while for depths from 2,263 feet down to 3,772 feet it is 1 degree Fahrenheit for 43 feet.

At a bore hole sunk by the Wheeling Development Co., at Wheeling, W. Va., which was 4,500′ deep and $4\frac{3}{4}$″ in diameter, and which was cased to the depth of 1,570′, the strata in nearly as normal condition as possible, and dipping only 50′ to the mile, the following results were shown:

The increase of temperature between points 1,350′ from the top and 2,236′ from the top, which is very nearly M. Libert's intermediate distance, was about 1° per 100′. From a point 2,236′ from the top to a point 3,730′ from the top the increase in temperature was about $1\frac{1}{10}$° per 100′. From a point 3,730′ from the top to the lowest point at which observations were taken, 4,462′, the increase was at the rate of $1\frac{11}{14}$° per 100′. In other words, from a point 1,350′ deep to a point 2,236′ deep the increase of temperature was about 1° for 100′; from a point 2,236′ to a point 3,730′ deep the increase was at the rate of 1° for each 77′ in depth, and from the point 3,730′ deep to the point 4,462′ deep the increase was at the rate of 1° for each 58′ in depth. The average increase in temperature from the point 1,350′ feet from the surface to the point 4,462′ from the surface was at the rate of about 1° for each 75′ in depth. The average rate of increase of temperature at the Sperenburg bore hole near Berlin, which is 4,170′ deep, was at the rate of 1° for each 60′ in depth. At the bore hole of Schladabach, near Leipsic, which is 5,740′ deep, it is at the rate of 1° for each 68′ in depth. A comparison of the results found at these different bore holes makes evident the fact that no positive rule for increase of temperature with depth can be adopted.

PROPOSED SCHOOL OF MINES AT BUTTE, MONTANA.

EFFORTS are being made to establish a school of mines at Butte, Montana, on the lines of the State School of Mines at Golden, Col. At the start it is proposed to erect a building large enough to accommodate one hundred students, so arranged as to permit of enlargement when needed. The proposed school building will be of stone and pressed brick, 100 ft. x 120 ft. in area, two stories and basement, and its estimated cost is $80,000. This building will contain the following compartments: A chemical laboratory, 34 ft. x 48 ft.; a chemical lecture room, 32 ft. x 32 ft.; a scale room, 16 ft. x 32 ft.; assay furnace, 16 ft. x 24 ft., to contain about twelve assay furnaces;

two laboratories, 24 ft. x 32 ft.; a professors office, 12 ft. x 16 ft.; a store room, 16 ft. x 48 ft.; a class room for geology and mineralogy, 32 ft. x 32 ft.; lecture room, 24 ft. x 32 ft.; a library, 24 ft. x 32 ft.; an office for the president, 16 ft. x 16 ft.; physical lecture room, 24 ft. x 32 ft.; metallurgy and mining room, 32 ft. by 32 ft.; two class rooms, (drawing), 32 ft. x 32 ft.; mathematics, room, 24 ft. x 32 ft.; also several reserve rooms.

Montana is one of the most important mining states in the Union, and the efforts of her enterprising citizens in the line of increasing the knowledge and skill of her mining population are most praiseworthy and deserving of encouragement. The better equipped a state's mining men are, the more valuable are her mineral possessions. If the Legislature liberally encourages this school, the state will reap profit from the investment. Intelligent mine officials, equipped with a first class mining education, invariably make the most of the mineral resources of any locality. The safer and more economically the great mineral wealth of Montana is developed the greater the wealth of the state. Therefore the investment in a first class school of mines will be a profitable one.

CARBON MONOXIDE AS AN ELEMENT IN DUST EXPLOSIONS.

THERE is some ground for a theory that a small percentage of carbon monoxide, (white damp), such as results from the discharge of a heavy shot of blasting powder, in the atmosphere of a dusty bituminous mine, will form an exceedingly explosive mixture. This theory has been advanced in Great Britain by Prof. Vivian B. Lewes. Prof. Lewes ignited a small weight of carbonite in a closed bomb, a part of the resulting gas (40% of which consisted of carbon monoxide) was mixed with air in a small gas receiver, and the gaseous mixture did not ignite on the application of a lighted match. A similar mixture was then formed, and coal dust being sprinkled into it, the whole was readily ignited by a lighted match. This experiment showed that the mere presence of a flame, without detonation and consequent compression, in such a mixture will produce an explosion.

Prof. Lewes states that experiments which he made early in 1895 showed clearly that carbon monoxide, when added even in small quantities to a dust laden atmosphere, caused it to become highly explosive. This fact seemed to him to be so important, in the view of the presence of this gas in the products of combustion of many explosives, that he thought it well to bring it to the attention of mine managers. Stress of other work prevented him from making further experiments to determine the exact quantity of carbon monoxide needed to make a dust laden atmosphere explosive. He, however, satisfied himself that the products of the combustion of many explosives used in mines produce exactly the same effect as pure carbon monoxide.

BRUTAL MURDER OF A PROMINENT MINE OFFICIAL.

MR. GRIFFITH G. ROBERTS, assistant superintendent of the Honeybrook division of the Lehigh & Wilkes-Barre Coal Co., with headquarters at Audenreid, Pa., was brutally murdered on the night of the 21st ult. Mr. Roberts was found that night between ten and eleven o'clock, alongside the Lehigh Valley tracks near the Lehigh Valley machine shops in Hazleton with his skull fractured. The engineer of a passenger train noticed Mr. Roberts alongside the track, stopped the train and he was taken to the Church street depot, Hazleton, for recognition. His features were so covered with blood that he was not identified by those present, and as there were still signs of life in his body he was immediately taken to the Miners' Hospital, where he lay in an unconscious state until he died early the next morning.

About twenty feet from where Mr. Roberts was found, a piece of gas-pipe about two feet long and two and one-half inches in diameter, with traces of blood and some human hair on it was found, and it is believed that the blow which killed Mr. Roberts was struck with this section of pipe. While it is certain that Mr. Roberts was murdered, the police and detectives are at a loss to assign a motive for the murder. The money in his pockets and his watch had not been taken, which proves conclusively that robbery was not the motive of the crime.

Mr. Roberts was one of the best known mine officials in Luzerne county, having moved to the Lehigh region some years ago from the Wyoming valley, where he also held an official position. Personally he was very popular, not only among the employes under him and with his official associates, but among people in general. He was a kindly, charitable man.

As a mine official he ranked among the most competent in the anthracite region and enjoyed the confidence of his superior officers to a remarkable degree. His death under any circumstances would have been a shock to hosts of friends throughout the region, and his brutal murder has intensified this greatly. Mr. Roberts was a comparatively young man, being but forty-four years of age, and is survived by a wife and two children.

Luzerne county is gaining an unenviable reputation for the number of brutal murders committed in that section of the country. There are fully a score of unconvicted murderers in the Luzerne county prison, and the fact that such is the case is a disgrace to the county and to the county officials. The immunity which murderers have enjoyed in that county during the past few years is, in a measure, responsible for the death of Mr. Roberts. It took over a score of executions in the Schuylkill region to effectually check the work of an organized band of assassins some years ago. The measures that were effective in breaking up a murderous organization in the Schuylkill region will be equally effective in checking murders in the Lehigh region.

BOOK REVIEW.

THE PRACTICE AND SCIENCE OF MINING ENGINEERING, by W. Fairley, Ph. D., F. G. S., Mining Engineer. Octavo; cloth; 366 pages. Published by James Fairley, Shafto House, Chester-Le-Street, England. This is Mr. Fairley's latest, and certainly one of his best books on mining. The plan of the treatise is such that the student is carried by an easy grade through the successive stages of the subject by a series of well arranged questions and answers. The text of the book is excellent, and the only adverse criticism we can make is that the numerous illustrations are too roughly made. They are clear enough and fully explain Mr. Fairley's ideas, but the mechanical work on them is of such a nature as to cheapen the appearance of the book and thus give the hasty examiner of it a wrong impression as to the sterling value of its contents. We regret that this is the case, and trust that in future editions Mr. Fairley will see that the illustrations are redrawn in better shape so that they will be in better harmony with the text.

PENNSYLVANIA GEOLOGICAL SURVEY, a summary description of the geology of Pennsylvania, Vol. 3, Parts I and II, and an index in separate volume. These publications complete the Second Geological Survey of Pennsylvania, as far as it could be completed, under the adverse circumstances imposed on it by a legislature that could not recognize the value of a full knowledge of the great mineral wealth of the state. Some day the majority of districts of the great State of Pennsylvania will realize the necessity of intelligent representatives at Harrisburg, and when that day arrives a *third* geological survey will be considered necessary, and its cost will be infinitely greater than a rational continuance of the last survey would have been.

A PRACTICAL HAND-BOOK ON THE CARE AND MANAGEMENT OF GAS ENGINES, by G. Lieckfeld, C. E., translated by G. Richmond, M. E., with instructions for running oil engines. 103 pages, cloth, $1.00. Published by Spon & Chamberlain, 12 Cortlandt St., New York. The adaptability of gas or oil engines for mining work, and their economy and success wherever used makes this little volume a very useful and important one for mine managers. It is one of the series of practical hand books issued by Messrs. Spon & Chamberlain. It is a very practical and useful publication.

THE OHIO MINING JOURNAL, official organ of the Ohio Institute of Mining Engineers, Nos. 22 and 23, embracing the proceedings of the winter meetings held at Columbus in January 1893, and 1894, and the excursion to Congo, Ohio, on January 19, 1894. Published by R. M. Haseltine, Secretary of the Institute. Both parts of this publication contain, besides official addresses and reports, papers on mining subjects by practical mining engineers and mine managers, and intelligent discussions of the subjects treated on by the members of the institute.

HANDBOOKS FOR MINING STUDENTS, PART III. Paper; 48 pages. Published by *The Science and Art of Mining*, Wigan, England. Price, sixpence, by mail seven pence. This Part III of the series of handbooks treats on ventilating methods and appliances, and the use of the anemometer, barometer, thermometer and water-gauge, by a series of 146 questions and answers. The author's work is well done and cannot fail to be a boon to mining students, and is worthy of the attention of all practical mining men.

PERSONALS.

Mr. James McLaughlin, recently with the Philadelphia Engineering Works, Ltd., has been elected secretary and treasurer of the Barr Pumping Engine Co. of Philadelphia. Mr. W. W. Lindsay is general manager of the latter company.

Mr. E. Webster, the well known expert in steam appliances, for many years with the Stillwell & Bierce and Smith & Vaile Co., has been appointed western representative of the well known Goubert Manufacturing Co. of New York, with office at No. 1403 Monadnock Block, Chicago, Ill. Mr. Webster will look after the western demand for the Stratton separators, feed water heaters, engine condensers and steam traps, manufactured by the Goubert Co.

LEGAL DECISIONS ON MINING QUESTIONS.

(Reported for THE COLLIERY ENGINEER AND METAL MINER.)

Correction of Certificates of Mining Claims.—Where an original certificate of location of a mining claim is subject to amendment, a certificate amendatory of it will relate back to the date of the original. But where the original is void, a subsequent certificate cannot, as an amendment of it, so relate back.

Moyle v. Bullene (Ct. App. Col.) 44 Pacific Reporter, 71.

Measure of Damages for Trespass on Coal Lands.—In an action for an intentional trespass to land, consisting of the mining of coal from same, the party suing may recover as damages, the highest value of the coal after severence until suit was brought, without any allowance for the cost of mining the coal.

Sunnyside Coal & Coke Co. v. Reitz (App. Ct., Ind) 43 N. E. Reporter, 47.

Negligence in Blasting.—Under the laws of Maine (and other states) it is the duty of persons engaged in blasting lime or other rocks, before each explosion, to give seasonable notice of same, for the protection of persons within the limits of danger. Failure to give such notice is in itself negligence, and renders the party liable for injuries resulting, whether caused by flying debris or the frightening of horses by the noise of the explosion.

Wadsworth v. Marshall (Sup. Jud. Ct., Me.) 33 Atlantic Reporter, 30.

Lien for Coal Furnished Manufacturing Company.—Under the law of North Carolina disabling corporations from conveying their property, by mortgage, freed from liability on a judgment obtained against such corporations "for labor performed, for material furnished, or wrongs committed by such corporations, their agents or employes," liens for coal furnished after making the mortgage are superior to it; the coal being used by such company to enable it to operate its plant.

Pocahontas Coal Co. v. Henderson Elec. Light and Power Co. (Supreme Court, N. C.) 24 S. E. Reporter, 22.

Mining Partnership in Montana.—To constitute a mining partnership under the provisions of the laws of Montana, two or more persons must not only own or acquire a mining claim for the purpose of working it, but must actually engage in working the same; and the fact that one part owner of the claim is charged by another with unlawfully extracting ore from a portion of a vein, the apex of which is alleged to be within the claim, does not create the relationship of mining partners between the parties.

Anaconda Copper Mining Co. v. Butte & B. Mining Co. (Supreme Ct., Montana) 43 Pacific Reporter, 924.

Knowledge of Danger by Employe.—A complaint alleging that an employe's injuries were caused by the negligence of a company in removing four consecutive bents, and the accumulated rocks and dirt on them from the interior of a tunnel, for the purpose of reconstructing such tunnel, and without making any inspection of the top of said tunnel and in ordering the employe—a youth of tender years, who had no experience and was not instructed in such work and its attendant dangers—to remove said bents and the rock and dirt from the place where they fell, which was so dark that he could not see the impending danger, and that while engaged in removing the debris from said tunnel, he was injured by a fall of rock from the top, does not show that the employe must have perceived the danger with reasonable exercise of his faculties.

L. N. A. & C. Ry. Co. v. Cornelius (App. Ct. Ind.) 43 N. E. Reporter, 31.

To Whom Royalties are Payable Under Gas Lease.—An owner in fee simple makes an oil and gas lease for a term of five years, and as much longer as the premises are operated for oil and gas, or the rent for failure to commence operating is paid, for, among other things, one-eighth part of the oil produced and saved, to be delivered in the pipe lines to the credit of the lessor. The lessor then sells and conveys one undivided moiety of the one-sixteenth part of all the oil produced and saved. Afterwards, but before any oil is bored for or produced, the lessor sells, conveys and grants the land in fee simple to his six children, to each one a part by metes and bounds, in consideration of natural love and affection, by deed of general warranty "except that the party of the second part takes the same subject to any lease for oil or gas made by the party of the first part or any sale of royalty for oil or gas made by him"; and by the same deed he retains full control of said land in all respects, and for all purposes during his life time. Soon afterward oil wells are bored, and oil produced, saved and put in the pipe lines in large quantities. The Supreme Court of Appeals of West Virginia held that, the one-eight royalty goes of right to the tenant for life (the lessor) and his grantees, during the continuance of his estate for life, and not to the owners of the fee expectant.

The tenant of an estate for life, unless restrained by covenant or agreement, has a right to the full enjoyment and use of the land and all its profits during his estate, including mines of oil or gas open when his life estate begins, or lawfully opened and worked during the continuance of such estates.

Koen v. Bartlett, 23 S. E. Reporter, 664.

LARGEST CIRCULATION.

In all America no other mining publication has credit for so large a circulation as is accorded to THE COLLIERY ENGINEER AND METAL MINER, published monthly at Scranton, Pa., and the publishers of the American Newspaper Directory will guarantee the accuracy of the circulation rating accorded to this paper by a reward of one hundred dollars payable to the first person who successfully assails it.—*Printers' Ink*, May 6, 1896.

Our mailing list is open for the inspection of any person desiring to assail the rating given this journal. What other mining publication will show how many subscribers it has, and how its clientage is distributed? This is a pointer for advertisers.

Correspondence

This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

Correspondence should be in as simple language, and as free of technical terms and formula as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

An Algebraic Problem.

Editor Colliery Engineer and Metal Miner:

SIR:—Please publish the following in your next issue: A and B dig a ditch 100 feet long for $100. Each receives $50; but A receives 25 cents per foot more than B, how many feet does each dig. J. P. WOLFE,

May 11, 1896. Big Stone Gap, Va.

Machinery Catalogues.

Editor Colliery Engineer and Metal Miner:

SIR:—I wish to state that among the many valuable catalogues that I have received from progressive establishments that of the Lidgerwood Manufacturing Co., entitled "Contractors Methods," second edition, is one of the most interesting on conveying machinery. With their usual liberality the pamphlet is sent free on application to the company's offices in New York, Chicago, or Boston. Respectfully, E. W. BAILEY,

Rock, W. Va.

May 12th, 1896.

The Fifth Root.

Editor Colliery Engineer and Metal Miner:

SIR:—I hope Mr. Thomas Hannah will be interested to find that *any root* can be found *correctly* by the rules of Ajax.

To find the fifth roots of the examples he furnishes, proceed as follows: Raise each of the numbers to the sixth power with a false root, as in the case of 9, make the false root 2, and in the case of 21035.8, make the false root 8, then extract the sixth roots of the products. Next lower the numbers 9 and 21035.8 to the fourth powers by dividing with the false roots, when half the sum of the sixth and fourth roots will be the fifth root nearly correct, and to find the absolutely correct root, let him now take the approximate root found, and raise and lower with it as before when he will find that he can repeat the process until the fourth root will come out the same as the sixth root, and then he will know that the root is found absolutely correct.

Find the fifth root of 9.

$$\left(\sqrt[6]{9\times 2}+\sqrt[4]{\frac{9}{2}}\right)\div 2 = 1.50489.$$

Now, we know that this root will be too small, therefore we next take 1.55 as,

$$\left(\sqrt[6]{9\times 1.55}+\sqrt[4]{\frac{9}{1.55}}\right)\div 2 = 1.55192.$$

Again, $\left(\sqrt[6]{9\times 1.55192}+\sqrt[4]{\frac{9}{1.55192}}\right)\div 2 = 1.55184$ +, and the correct root is 1.55184 +.

Next let us find the fifth root of 21035.8, then,

$$\left(\sqrt[6]{21035.8\times 8}+\sqrt[4]{\frac{21035.8}{8}}\right)\div 2 = 7.27126.$$

We know this root will be rather too small, as 8 reduces the fourth root, more than it increases the sixth, therefore let us take 7.32 for the next trial; then

$$\left(\sqrt[6]{21035.8\times 7.32}+\sqrt[4]{\frac{21035.8}{7.32}}\right)\div 2 = 7.3212 +$$

therefore repeat again and find the correct answer, which is 7.3213.

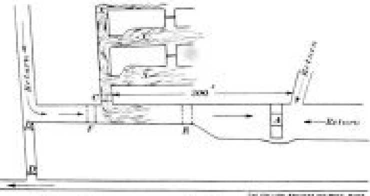
The correct roots can be found by shorter cuts, with the exercise of a little judgment, but the processes here carried out, are purposely made roundabout to afford explanation.

The fourth and sixth powers are employed because the root of one is found as the square root of the square root, and the other is found as the square root of the cube root. Yours etc., AJAX.

Fighting Gob Fires.

Editor Colliery Engineer and Metal Miner:

SIR:—In looking over the February, 1896, issue of THE COLLIERY ENGINEER AND METAL MINER, on page 163, Fig. 125, the writer of an article on "Gob Fires" says that the stopping *R* should be built first and the stopping *F* last. As this is the reverse of the practice I followed for two years in fighting gob fires, I respectfully disagree with the writer and desire to draw his attention to his error. There may be a mistake in the description of the sketch which may mislead others in such work and cause an explosion. He said that to remove large quantities of gas from a mine plenty of fresh air should be used. This is all right, but the reverse of this is just what he should have said in the case of an uncontrollable gob fire as shown on his sketch. It is evident that oxygen is the supporter of all combustion and the quicker it is shut off the sooner the fire will be extinguished, and the products of combustion will neutralize the fire-damp. One of the claims of Sir Humphrey Davy on his famous safety lamp was that the products of combustion neutralize the gases that enter the gauze of the lamp. The Mueseler lamp is constructed on the principle that only sufficient air is allowed to enter to support combustion and when the air is contaminated with an explosive mixture, the lamp will go out. These furnish good examples in this very case of stopping building. If the stopping *F* is constructed first, there will be no danger of an explosion as I have shown that the products of combustion generated from the fires will neutralize the fire-damp. To allow the volume of fresh air which enters the mine to flow into the heated space and there mix with the fire-damp while building the stopping *F* on the intake (which should be built first) there is great danger of an explosion. On the other hand, if the stopping *F* on the intake is built first the heated products of combustion from the fire will find their way leisurely to the upcast while the stopping *R* is being erected on the out-take end. There should be a pipe or valve on the stopping *R* to allow water gauge and thermometer readings to be taken so as to show the pressure and temperature.



A—Air Shaft. *X*—Gob Fire.
D—Door. *C*—Stopping Blown Out.

In continuation of this subject I submit a sketch of a gob fire which actually occurred in No. 5 shaft at Staunton, Ill., in 1889, and I refer the following question to some of your able readers: In this case there was a small percentage of gas in the return air. Which stopping should be built first, that marked *F* or that marked *R*, and how should the stopping *R* be built with the smoke and heated gases generated by the fire coming out in large volumes? The stopping *C* was blown out.

Trusting that some of your able readers will discuss this matter and bring out points which will effectually settle the controversy of which stopping should be built first, I remain Yours respectfully,

WM. M. MORRIS,

April 15, 1896. Pueblo, Colo.

The Natural Philosophy of a Ventilating Regulator.

Editor Colliery Engineer and Metal Miner:

SIR:—Thanks for copies of journal sent to me. In the March issue I see that you review my "Philosophy of a Ventilating Regulator" in a curious manner.

1st. You describe myself as "a young man of small experience." As a matter of fact, however, I have been a pitman for 31 years.

2nd. You are at "a loss to understand why Mr. Pamely should be singled out for attack," and you think that my ideas of respect for such writers "require a little regulating." Did it never occur to you that it was just my very profound respect for Mr. Pamely which led to my naming him? Errors by unknown writers may pass unnoticed, but their reproduction by eminent men like Mr. Pamely creates the very *raison d'etre* of works like my own.

3rd. You "remind" me that "in our issue of November last we gave on page 92 of the COLLIERY ENGINEER AND METAL MINER the correct expression for the velocities of air currents through regulators, and that is the month in which Mr. Halbaum printed the treatise under consideration."

I am not sure that I see the point of this "reminder." Do you wish to imply that mine is *not* a "correct expression?" If so, you must have read my pamphlet very carelessly, for although expressed in different letters, my formula is exactly the same as yours, and brings out the same results; the only difference arising from your taking vena contracta at .65, while I take the mean of .62 and .65. Hence our formulæ are practically the same.

If you don't impugn the accuracy of my formula—and you cannot do this unless you impugn your own—the object of your "reminder" can only be to suggest literary piracy on my part. If this is your object, the boot is entirely on the other leg. It is true that my work was printed in the same month as you gave your formula (which, after all, is really Murgue's) but it is not true that my work was then printed for the first time, for the pamphlet you reviewed was simply a reprint of articles that had previously (March-August 1895) run through the *Science and Art of Mining*. Hence your "reminder" only shows that you gave the "correct expression for the velocities of air currents through regulators" some months *after* I had published the same in another journal that circulates all over the world.

4th. Your next "reminder" is entirely beside the question. I was not discussing fans, but regulators. Hence it did not come within my province to controvert errors affecting the "velocities of currents entering fans." I was speaking of the fact that an extra resistance of one kind (as friction) in one split, might be compensated by an extra resistance of another kind (as velocity) in the other split. And I quoted Murgue's theory as an illustration of equivalent values of different resistances. And I did say, as you quote, that "to refuse to grant *its truth as an abstract statement* would be to call in question the whole theory of the conservation of energy." And you will, I think, admit that the truth of an abstract statement is one thing, while the truth of a sub-theory supposed to be based on that statement is quite another thing.

I think, sir, that you will see that the tone of your review was rather unfair, and I hope you will publish this letter as I have written it. If you have any rejoinder to make, I have no doubt you will be kind enough to send me a copy, as you have already sent me the other copies. I am, sir,

Yours faithfully,

H. W. HALBAUM,

116 Blenheim Street, Newcastle-on-Tyne, England.

April 25, 1896.

[In our review of Mr. Halbaum's book, we did not mean to imply literary piracy on his part, for we said then, as we repeat now, his work is a good one. What we principally criticized was his sharp criticism of Mr. Pamely's formula for regulator quantities, and we merely mentioned our own method of treating the subject (written before we saw Mr. Halbaum's formula) as a better way of treating the matter. That Mr. Halbaum is technically correct, and Mr. Pamely wrong on the subject of regulators, we frankly admit, but we must say that the latter's efforts to advance the science of coal mining are deserving of courteous treatment, for his excellent publication is unquestionably the most complete book on coal mining as yet published, notwithstanding that in its nearly 700 pages there is one incorrect formula. Mr. Halbaum deserves credit for correcting this error, but we must deprecate the caustic manner in which it is treated.—EDITOR.]

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue or three months subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for June.

QUES. 229. If we burn acetylene gas, from the liquid acetylene, in our new lamp, do you think it will be safe? Our object is to obtain a small white light of high potential without the use of a wick. Should your judgment be favorable, will you please say what advantages this light will give us in restricting the size of the lamp, and further, say if you think the burning of this gas will produce over much soot and choke the meshes of the gauze.

QUES. 230. What very decisive proof can you give us in support of the conclusion, that there were immense stretches of dry land on the globe during Cambrian and Silurian times?

QUES. 231. The number 390,000 is ½ times the eighth power of the length of one of the sides of a cage guide in inches, and if the guide is square, what is the measure of one of the sides, and what is the length of the guide in feet?

QUES. 232. How many units of heat should a pound of coal of the following composition develop: Carbon, 82 per cent.; volatile and combustible matter, 6 per cent.; oxygen, .6 per cent.; nitrogen, .8 per cent.; ash, 10.6 per cent.

QUES. 233. We are about to introduce an endless rope haulage at our mine for an output of 800 long tons per day, and we will require a main haulage for the total delivery at the shaft, and the length of this road will be 1,325 yards. The coals from three separate districts will feed on to the main haulage rope, with belts worked by sheaves in gear with the return sheave of the main haulage. Now if we call the districts *A*, *B*, and *C*; then from the terminus of the main haulage the lengths of the district roads are *A*, 412 yards; *B*, 804 yards; *C*, 601 yards; the delivery of coals from each district will be *A*, ¼; *B*, ⅓; and *C*, 5/12 of the total output, and what I wish to know is two things, and the first is this: If all the four bands of rope are run at the equal velocities of two miles an hour, how far apart will the cars be on each band of rope, supposing the load of a car to be one ton. The second thing I wish to know is, if I were to put a chalk mark on each of the four bands of rope on the junction sheaves, that is, where the four bands of rope come together, at 6 o'clock in the morning, when would the marks on the four bands come together again at the same place? and say what practical lesson you would learn from this experiment.

QUES. 234. During the working of regular stratified coal seams, sometimes a seam cuts out, or appears to be cut off by an upper stratum of rock that is not conformable to the seam. At other times the seam is cut out by a conglomerate-like deposit. Now, if you were a mine superintendent and either of these occurrences were met with in a mine under your charge how would you report the matter to the operators?

Answers to Questions Which Appeared in the April Issue and for Which Prizes Have Been Awarded.

QUES. 217.—During the course of some experiments we have been making with a Mueseler lamp, with the view of perfecting our new safety lamp, we have found that when we make the top diameter of the conical funnel five-sixteenths of an inch, the lamp flame dies out when the entering air contains about 7 per cent. of marsh gas, and when we make the top diameter of the funnel five-eights of an inch the lamp is not safe in an explosive mixture. We will therefore feel obliged if you will explain to us how it is that the lamp is safe with the small diameter and absolutely unsafe with the large one.

ANS.—The expansive force of the exploded gas in the lower chamber of the lamp is not strong enough to overcome the resistance of the conical chimney and force the flame through the small aperture at its top, but is sufficient, however, to develop an outward and upward pressure large enough to prevent the inflow of the outer air to the lamp flame, thus extinguishing the same by excluding the oxygen necessary to support it.

If we increase the diameter of the top aperture of the chimney from $\frac{5}{16}$ to $\frac{5}{8}$ of an inch, we not only increase the area of this aperture four times, but we also change the converging sides of the chimney to a more perpendicular position, thereby diminishing the resistance to the upward movement of the burning gas sufficiently to allow the flame to reach the upper part of the lamp and explode the gas contained there.

In this case the lamp flame will not be extinguished, because the unobstructed upward flow of the burning gas through the chimney will cause the gaseous mixture outside of the lamp to enter the lower chamber with an increased velocity; explosion will quickly follow explosion inside of the lamp and in a few moments it will become as dangerous as an open light.

JOHN VERNER, Lucas, Iowa.

Second Prize.—ROBT. REAY, Holsopple, Somerset Co., Pa.

QUES. 218.—We are ventilating a mine with a furnace, and the quantity of fresh air entering per minute is 100,000 cubic feet. The furnace consumes 1.5 long tons of coal per hour. The composition of the coal is 78 per cent. fixed carbon, 10 per cent. volatile hydro-carbons and 12 per cent. ash. The volatile hydro-carbons may be taken at the average composition of $C_2 H_4$. Now, we wish to know what will be the volume measure per minute of the air and gases ascending from the furnace in the upcast shaft, when the temperature of the descending air is 60° F., and that of the ascending air is 200° F.

ANS.—The 100,000 cu. ft. of air at 60° F. would become at 200° F., $100{,}000 \times \frac{459 + 200}{459 + 60} = 126{,}973.4$ cu. ft.

The furnace consuming 1.5 long tons per hour would consume per minute $\frac{1.5 \times 2{,}240}{60} = 56$ lbs. coal per minute, composed of:

Fixed carbon	$= C$	$56 \times 0.78 = 43.68$ lbs.
Volatile matter	$= C_2 H_4$	$56 \times 0.10 = 5.60$ "
Ash		$56 \times 0.12 = 6.72$ "
		56.00

In the 5.60 lbs. $C_2 H_4$ there are $5.60 \times \frac{4}{32 + 4} = 0.62216$ lbs. hydrogen and $5.60 - 0.62216 = 4.97784$ lbs. carbon. Hence, the total combustible is $43.68 + 4.97784 = 48.65784$ lbs. carbon, and 0.62216 lbs. hydrogen. The carbon will burn to carbonic acid $C O_2$, but in doing so will not add to the total amount of air and gas, as the $C O_2$ composed of one volume of C and two of O is only two volumes or the same as the contained O which is already summed above in the air. The H burning to water $H_2 O$ will form two volumes, but one volume of O is included above, so we add one-half the H to get the increment in volume. 1 cu. ft. H at 32° F. weighs 0.00558 lbs. and $\frac{0.62216}{2}$ lbs. would be 55.75 cu. ft. at 32° or $55.75 \times \frac{459 + 200}{459 + 32} = 74.8$ cu. ft. at 200° F. Hence, total amount of gas and air passing per minute out the furnace is $126{,}973.4 + 74.8 = 127{,}048.2$ cu. ft.

CHAS. E. BOWRON, Tracy City, Tenn.

Second Prize—DAVID P. BROWN, Dunbar, Fayette Co., Pa.

QUES. 219.—We have a seam of bituminous coal 4.5 feet thick; it is lying nearly level. The bottom rock is hard and strong, but we have a following of 4 feet of slate that we cannot keep up. The shafts when sunk will be 800 feet deep, and we will therefore be obliged to you if you will explain with a sketch how we should work this seam so as to obtain the highest possible percentage of large coal, and yet be able to keep the roads and rooms in safe condition without the loss of much timber.

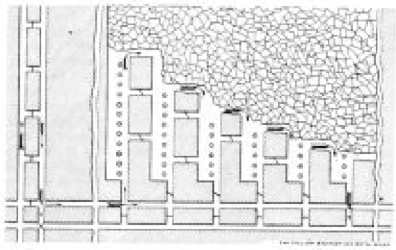
ANS.—Perhaps, generally speaking, a method of longwall would give the best answer to this question; but as there are many reasons why longwall would not be successful if applied to such a seam (under the conditions stated), we shall give the answer which we think will give the most satisfactory results in North America.

Further, the question refers to rooms, and as the term room is seldom used in connection with longwall working we presume longway is not the answer expected.

We take it that the "following" can be maintained in its position for a short distance and at least for two days, so that it can be removed from the roadway to the gob. The "following" from the roadway will fill the gob and support the part of the "following" in the gob. The gob being thus closely stowed will make a strong support to the superincumbent strata over the entire mine as the work progresses, even when the pillars are removed, and only the stumps (entry stumps) are in. Four feet of "following" will stow or nearly stow the waste behind, when the pillars are drawn, and as the pressure due to 800 feet will not compress the stowing to anything like its original compactness we will have only a small amount of subsidence and that so slowly that it will cause little inconvenience.

Now, that I have given a reason for the answer I will proceed with it:

In the sketch are shown gob entries in order that space may be furnished for the "following." It shows rooms with only one road so that the dirt may be stowed on one side and the road located so that it will be ready



to convey the coal from the pillars as it is drawn back, as well as forming a haulway for the coal from the advancing room. By this method, if the timber put in is a greater item of cost than that due to removal it can be readily removed. In the first place only side props (and perhaps a few cross bars) need be used. The props, used to keep up the "following" until the gob is stowed, can be removed as the room advances or the pillar retires and be used over and over again. The roadside props and any cross bars that have been used in the roadway, can be removed as the pillar coal is taken out.

The width of rooms has not been specified as that must depend upon the per cent. of increase of the "following" taken out of the roadway.

The writer has worked by this method a seam averaging about 3 feet with a "following" varying from 18 inches to 4 feet with good results, but owing to the lack of skilled labor and other causes, longwall was an utter failure.

W. D. L. HARDIE, Box 793, Birmingham, Ala.

Second Prize—JOHN FLETCHER, 428 Tonti St., La Salle, Ill.

QUES. 220.—We have a ventilating fan exhausting from our mine 150,000 cubic feet of air per minute with a water gauge of .8 inch, and we wish to set up another and larger fan to increase the ventilation to 250,000 cubic feet. We will, therefore, be obliged to you if you will furnish us with the following values for the new fan, so that we may secure the best results:

First—The diameter of the fan.
Second—The breadth or length cylinderwise.
Third—The number of revolutions.
Fourth—The radial length of the blades.
Fifth—The area of the orifice of entry.
Sixth—The area of the throat.
Seventh—The area of the orifice of discharge.
Eighth—The effective horse power of the fan, taking T instead of M for the pressure per square foot.

ANS. $150{,}000^2 : 250{,}000^2 :: .8 : 2.2$ inches W. G.

First—The diameter of the fan:

$$D = \sqrt{\frac{250{,}000}{200}} = 35.36 \text{ feet.}$$

Second—The breadth or length cylinderwise:

Taking the average velocity at 5 feet per second $\frac{250{,}000}{5 \times 60} = 833.3$ sq. ft. area. Then, $\frac{833.3}{3.1416 \times 35.36} =$ 7.5 feet wide.

Third—The number of revolutions:

$$R = \sqrt{\frac{8{,}000{,}000 \times \text{W. G. } 2.2}{6 \times 35.36^2}} = 50 \text{ revolutions per}$$

minute, nearly.

Fourth—The radial lengths of the blades:

RULE.—There should be 7 inches in the radial lengths of the blades for every pound per square foot in the mine resistance. Then, $\frac{2.2 \times 5.2 \times 7}{12} = 6.67$ feet, the length of blades.

Fifth—$\frac{250{,}000}{1{,}300} = 192.3$ sq. ft., area of orifice of entry.

Sixth—The throat of the fan is equal in area to the port of entry $\frac{250{,}000}{1{,}300} = 192.3$ feet.

Seventh—The area of the orifice of discharge:

$$A = \frac{250{,}000}{2{,}600} = 96.15 \text{ square feet.}$$

Eighth—The effective horse power of the fan:

$$H = \frac{250{,}000 \times 2.2 \times 5.2}{33{,}000} = 86.6 \text{ H. P.}$$

JOHN FLETCHER, 428 Tonti St., La Salle, Ill.

Second Prize—WM. DONALDSON, Kangley, Ill.

QUES. 221.—In looking over a topographical map and the text of the notes of the survey, I observed three hills, and their apices were lettered S, T and U. The apices of S and T were shown to lie in a line that was bearing North 63° East from S, and the apex of U was shown to bear South 27° East from that of T. The mean angle of elevation of the southwest slope of S, measured from the foot of the slope at A, was 32° 15′, and the mean angle of elevation measured at B at the foot of the slope at the southeast side of U was 19° 56′. The vertical heights of the hills were: S, 784 feet; T, 472 feet, and U, 320 feet. The angle of elevation of the apex of S, measured from the level of the apex of T, was 6° 25′, and the angle of depression of the apex of U, measured from the level of the apex of T, was 4° 43′. I will be pleased to receive from you a sketch with the necessary explanation, showing the process by which you have found the distance in a straight line from A, at the foot of the southwest slope of S, to B, at the foot of the southeast slope of U.

ANS.—Let H = horizontal distance, V = difference in elevation, and D = the angle of depression or elevation, between any two points.

$$\text{Then } H = \frac{V}{\tan D}$$

$$\text{Hence, } A \text{ to } S = \frac{784}{\tan 32° 15'} = 1242.57 \text{ ft.}$$

$$S \text{ to } T = \frac{784 - 472}{\tan 6° 25'} = 2774.26 \text{ ft.}$$

$$T \text{ to } U = \frac{472 - 320}{\tan 4° 43'} = 1842.25 \text{ ft.}$$

$$U \text{ to } B = \frac{472}{\tan 19° 56'} = 882.39 \text{ ft.}$$

The triangle $A\ T\ B$ is right-angled at T, hence,

$$A\ B = \sqrt{A\ T^2 + T\ B^2} =$$

$$\sqrt{(1242.57 + 2774.26)^2 + (1842.25 + 882.39)^2} = 4853.72 \text{ ft.}$$

HERBERT A. WILCOX, Aspen, Colo.

Second Prize—JOHN A. RAY, Westville, Picton Co., N. S.

QUES. 222.—In a mine shaft in course of being sunk an iron kettle full of water was hoisted from the bottom at a mean velocity of 6 feet per second. The kettle was cylindrical in shape and 3.5 feet in diameter and 3.5 feet deep, and by some unknown cause a round hole had been cut through the bottom, and it had a mean diameter of 3 inches. The result was that the kettle left the sump in the shaft bottom full of water and arrived at the top of the shaft empty, and by coincidence the discharge of water just ceased at the moment the kettle reached the surface. Now, I will be obliged if you will deduce for me, out of these facts, the depth to which the sinking has advanced.

[A great number of competitors attempted this question, and none of them have succeeded in obtaining the correct depth of the shaft. In the next trial please notice four things: First, take the vena contracta at .62; second, take $2\,g$ at 64.32; third, take the fall of the center of gravity or the mean pressure at 1.75 ft; fourth, many gave the depth as 880 ft. and as many more gave it at 548 ft., but it is neither, for the one is too much and the other too little.—ED.]

Anti-Rust.

Mr. B. E. V. Luty, editor of the *Tin and Terne* of Pittsburg, estimates the quantity of tin, iron and steel roofing used in the United States at 600,000,000 square feet per annum. Metallic material now enters into buildings of all kinds so largely, in place of the wood which was formerly used, that it is safe to say that one thousand million square feet of metal—tin, iron and steel—are used each year in the United States in structural work of all kinds.

In mining operations millions of square feet of metal are used in pipes, roofs, stacks, shafting, head-frames, breakers, tipples, mill structures and bridges, not to speak of the great amount of machinery used in the industry. All of this great quantity of metal is constantly menaced by its arch enemy, rust, and much of it is subject to corrosion from acidulated mine water, gases, etc.

It may be truly said that there is hardly a single owner of any amount of this metal that has not, at some time or other, been disappointed in the paint used for its protection, frequently finding it ineffective and utterly unreliable; and, without proper protection, the process of destruction, being constant, ceases only when nothing is left for the insidious and omnipresent destroyer to attack.

Recognizing the extent of the vast field before them, Messrs. Allen, Ackley & Co., of 413 Vine street, Cincinnati, Ohio, some years ago placed on the market an anti-rust paint made especially and particularly for the protection of metal from rust or corrosion. *This material is a paint for metal, and is not made for any other purpose.* Its use is extending rapidly, the demand coming from all parts of the continent. The manufacturers include in their large list of patrons many of the largest manufacturing plants in the world, and the United States government.

It is not surprising that such a material should meet with a quick demand when we consider the needs of the world. It fills a requirement long felt and supplies a remedy urgently needed. It is with pleasure we note that the manufacturers are meeting with marked success and even in the present greatly depressed condition of general trade they have found it necessary to quadruple the capacity of their works in order to keep step with the demands of their growing business.

In the use of this excellent material there is an application of the old and truthful proverb that "An ounce of prevention is worth a pound of cure." The idea of mine managers erecting buildings at an expense of hundreds, and sometimes thousands of dollars, and machinery, that more frequently runs into the thousands than into hundreds of dollars, and not protecting them by a reliable and cheap preventive of rust and corrosion is wrong, and results in constantly increasing repair bills, and finally, the destruction of the metal in a comparatively short time.

THE METAMORPHISM OF COAL.

HOW IT OCCURS AND WHAT CAUSES IT.

The Conversion of Bituminous Coal into Anthracite and Graphite, and the Conversion of Carbonaceous Matter into Diamond.

BY H. BOLTON, F. R. S. E.

(From Transactions of The Manchester Geological Society.)

The subject of the metamorphism of coal presented itself to me during the course of an examination of the anthracites of Castlecomer, County Kilkenny, Ireland, and in a paper communicated to this society last session,* I drew your attention to what I supposed to be a thin layer of graphite upon the bedding planes of the coal.

In following the matter up since, I have found that whilst the general question of coal metamorphism has not been dealt with, yet a large number of cases have been recorded in which coal has been changed in various ways by the action of heat and other agencies. Cases in which bituminous coals have been metamorphosed into anthracite are numerous, whilst, as we shall see later, metamorphism has proceeded to an even greater degree and graphite has been produced; furthermore, it is by no means unlikely that the diamond owes its origin to a metamorphism of carbonaceous matter by the heat of intruded igneous rocks. The general features presented by coals, and their arrangement in an ascending series from wood and peat to anthracite, are well known.

The various stages of the process may be said to be marked by an increase in density and coherence of the coal, and a loss of volatile hydrocarbons in the form of gaseous compounds and water.

The general composition of a coal seam in its various stages from wood or peat is very well indicated in a series of analyses published by Professor T. Thorpe.† From these analyses the following table has been constructed:

	Carbon.	Hydrogen.	Oxygen and Nitrogen.
1. Wood and Vegetable Humus	54.8	4.8	40.4
2. Peat (4 varieties)	60.8	5.9	33.35
3. Lignite (2 varieties)	67.45	5.55	27.0
4. Brown Coal (4 varieties)	72.9	5.4	21.7
5. Bituminous Coals (30 varieties)	83.37	5.48	11.4
6. Anthracite	95.23	2.58	2.3

To these we may add graphite with usually 99 per cent. of carbon; and the diamond, which is almost pure carbon.

The analyses show that the conversion of one coal into another higher in the series is marked by an increasing percentage of carbon and hydrogen, and a decreasing percentage of oxygen and nitrogen. In the case of anthracite the carbon percentage is very high, and that of the hydrogen, oxygen and nitrogen low.

The fact that bituminous coals can be converted into anthracite is known chiefly by reason of the phenomena presented in the South Wales coal field, where the seams are wholly bituminous in the easterly portion, but pass into semi-bituminous or steam coals as they reach the center of the area, and into pure anthracites further west. The change from one to another is so gradual that no sudden modification is seen. There is no evidence of the change having been brought about by intrusive igneous rocks, such as we shall see occur elsewhere.‡ It has been determined, however, that the change from bituminous to anthracite coal takes place along a definite plane, which dips to the south-south-east.

In Pembrokeshire, which contains only anthracite coal and forms the western boundary of the coal field, violent crumplings and rock folding have occurred, to which the formation of the anthracite may be in some measure due. In Ireland, the coal measures are capable of division into an anthracite series, which is developed in the southern fields of Limerick, Clare, Cork, Tipperary, Queens County, Kilkenny, and Carlow; and a bituminous series occupying the northern fields of Arigna, Tyrone, and Ballycastle.

The greatest deposits of anthracite in the world are found in the eastern Pennsylvania region of the United States, where they cover an area of close upon 16,000 square miles. This field presents phenomena very similar to those of South Wales. There is the same passage from bituminous coal in one end of the field to anthracite in the opposite extremity, and a gradual loss of hydrocarbon compounds is associated with the conversion into anthracite. There is also the same development of earth-folds in the areas containing anthracite as is presented in the Pembrokeshire area.

Whilst whole coal fields of vast extent have been converted into anthracite, there is not wanting direct evidence of various agencies by which this change has been brought about in small and comparatively unimportant areas. Boue, Delesse, and others drew attention many years ago to the occurrence of a bituminous coal at New Cumnock, Ayrshire, which had been partially changed into anthracite and graphite by the intrusion of a basalt.

Similarly, at the Rowley Hills, in the South Staffordshire coal field, the thick coal has been penetrated by intrusive rocks, such as basalt, resulting in considerable metamorphism of the coal along the lines of contact. Usually the coal has been converted into a black powdery mass of a dull color, very friable, and almost destitute of inflammability,§ but in other cases it has undoubtedly been converted into anthracite.

Professor J. J. Stevenson** has most excellently summarized the American evidence relating to the occurrence of anthracite, and has given cases where it has been formed by contact alteration with erupted rocks. He instances localities in New Mexico, Colorado, Virginia, and North Carolina, and also records other cases where, with precisely similar contact, no alteration into anthracite has followed.

Instances of the conversion of bituminous coal into anthracite by intruded igneous rocks have been recorded in New Zealand.

In the Donetz coal field of South Russia, between the rivers Krinka and Miuss, the coals are bituminous in the west and change into pure anthracite towards the east.*

In the intermediate districts, the coal is frequently in an intermediate condition between bituminous and anthracite, and no satisfactory term can be applied to it.

The close analogy between the features of this coal field and that of South Wales in this country was commented upon by Murchison, as was also the close coincidence between the line of anthracite coal and the crystalline axis of the Southern Steppes, a subterranean prolongation of which was supposed to have been the agent which converted the former bituminous coal into anthracite.

From the cases we have enumerated, it will be evident that the passage of bituminous coals into anthracite has been most clearly established and that this change has been brought about in a variety of ways, of which those by means of erupted rocks and the proximity of flexures and foldings are perhaps the most evident.

That graphite has been formed in some cases as a result of the same causes which induced the formation of anthracite, and either as a further stage of metamorphism of it, or along with it, is not commonly known, the metamorphism of coal rarely proceeding so far.

The occurrence of graphite with anthracite at New Cumnock, Ayrshire, was first described by Nicholt in 1844, and has often been mentioned by late observers. The mine is traditionally reported to have been in operation for nearly a hundred years, and was finally closed in 1848. I am indebted for a considerable amount of information relating to this mine to the kindness of Mr. John Smith,‡ of Monkredding, Ayrshire, a gentleman who has devoted considerable attention to the Ayrshire coal field. With great generosity, Mr. Smith has further sent me a valuable series of specimens which illustrate the special feature of the mine, and which he desires me to pass over to the Manchester Museum, Owens College, on the completion of this paper.

The conditions under which the coal occurs in the Craigman mine are so peculiar that I purpose dealing with them at some length in a later part of the paper.

A section at the entrance to the mine is as follows:

	Ft.	In.
Boulder clay	—	—
Sandstone, coarse-grained, hardened and shivery	4	0
Porcelainized shale, light colored	0	11
Hard shale, bluish colored	0	11
Porcelainized shale, bluish colored	3	1
Decomposing trap (basalt)	6	4
Solid trap (basalt), coarsely crystalline	5	0
Altered coal	6ft. to 8	0
Basalt?	—	—

Mr. Smith writes me that he has examined nearly every accessible part of the mine, and has come to the conclusion that the basalt penetrated the coal bed in such a manner as to break it up into detached patches, the smaller of which have been converted into graphite.

Nearly all the coal patches are much charred, and present a columnar structure, the columns lying in every possible direction, but more usually parallel to the basalt. When the coal approaches the basalt, it passes into a thin layer of massive graphite, which is closely applied to the latter.

These features are well demonstrated by the specimens which are now before you.

Much of the graphite presents a similar columnar structure to that of the coal, the columns however holding together much more firmly, those of the coal often falling away from each other when dug out.

In the paper by Professor Stevenson, which has just been read,§ you will have noticed that the conversion of coal into graphite is a familliar feature of certain mines in the United States, especially in New England, where the anthracite coal is stated to be largely graphitic, the coal at Mansfield being "like graphite or plumbago."

Mr. E. W. Parker, in his coal report for the year 1892** says: "In the New England basin the original coal beds have been metamorphosed into graphite and graphitic coal, which have special uses, although not classed by the trade as anthracite."

At Cranston, and also at Worcester, Mass., the coal is anthracitic and rich in graphite. From the latter locality, Professor Stevenson has kindly sent me a specimen which is so rich in graphite that one would be naturally inclined to doubt its origin from coal.

In a letter which accompanied the specimen he states "the piece of coal which I send you does not exhibit much completely changed carbon, and is less graphitic than some specimens which I have seen."

Graphite is also mentioned as occurring in the Laramie beds of New Mexico. In the latter case, the conversion into graphite has been brought about by an intrusion of basalt.

Graphite has also been found in association with coal beds of Upper Cretaceous age at Karsok, in Greenland, where the whole series of beds were found to rest upon gneiss, and to be in close association with basalt, which was ejected subsequently to the deposition of the Cretaceous deposits, and before the commencement of the Tertiary period.††

My colleague in the Manchester Museum, Mr. F. G. Pearcey, has kindly furnished me with the accompanying note extracted from the journal which he kept whilst attached to the "Challenger" expedition of 1872-6.

"At Port Darwin, in the Falkland Islands, some beds, locally known as coal beds, are found. They are beds of bituminous material, interbedded with clay slates, which form the most striking geological feature of the islands. The bituminous beds sometimes run out into a sort of culm, the transition of the latter into a typical graphite being also clearly marked."

Fragments of this graphite were often used by Mr. Pearcey on board ship for the purpose of marking boxes containing specimens prior to their being stored.

Whilst in the cases just enumerated the conversion of coal into graphite is undoubted, in the great majority of cases there is no evidence to show what was its original condition. It is, however, significant to note that whilst the purest forms of graphite are associated with igneous and more especially metamorphic rocks, and graphitoid anthracite with sedimentary rocks more usually of Carboniferous age, yet in the mica schists and clay slates of the Saxon Erzgebirge there is a graphite or "graphtoid" which still retains the property of combustion.*

In rocks of Pre-Cambrian age in Canada, Sir J. W. Dawson has found large quantities of graphite, in some of which he could distinguish traces of vegetable tissues.†

Pure graphite in its most familiar form has been obtained in the British Isles from Borrowdale in Cumberland, Beary in the Isle of Man, Grampound and Boscastle in Cornwall, and Killimuir in Scotland. Amongst other countries may be mentioned Ceylon, Canada, Bohemia, Algeria, Norway and Finland. It has been found in association with mica schist, gneiss, basalt, quartz and slates.

If we except the graphitoid of the Saxon Erzgebirge, graphite is destitute of volatile hydrocarbons, and consists of a slightly higher percentage of carbon than anthracite, together with a slight quantity of mineral ash such as silicate of alumina, sesquioxide of iron, and other compounds. In the development of graphite and anthracite from an originally bituminous coal—as in the case of the specimens before you from Worcester, Mass., U. S. A., and New Cumnock, Ayrshire, and in the occurrence of a combustible graphite in mich schist—we have, I think, conclusive evidence of the possibility of the origin of graphite from a vegetable source, the theory upheld by Dawson and others in respect to the graphite found in the Pre-Cambrian rocks of Canada.

The purest mineral in the carbonaceous series is the diamond, which consists of more than 99 per cent. of carbon. The diamond occurs in association with a variety of rocks, but in most cases these are of sedimentary origin, and show unmistakably that the diamonds which they contain have been derived from pre-existing rocks destroyed by denuding agencies.

In most cases, as at Bingera, in New South Wales, the matrix of the diamond is either a conglomerate or coarse sandstone; rocks whose nature is an evidence of their derivation from older rocks. In regard, however, to the diamond fields of South Africa, there is good reason to believe that the diamonds are still in the parent rock, and that they owe their origin to that agency which has operated in the origin of certain anthracites and graphites.

In the De Beers mine at Kimberly, which may be taken as typical of all, a volcanic "pipe," which forms the diamantiferous area, is surrounded by a series of deposits of a mixed character, in which carbonaceous shales of Triassic age predominate.

The deposits in descending order are as follows:

	Feet.
Surface soil	5
Basalt	51
Black carbonaceous shale	250
Melaphyre	400
Quartzite	400
Black carbonaceous shale	100

The material of the pipe has been described by Prof. Bonney‡ as a serpentinous breccia; by Mr. E. J. Dunn as a decomposed gabbro; and by Messrs. Hudleston, Rupert Jones, and Davies as a volcanic mud. The general feature of the diamantiferous areas, for there are four "pipes" already known, have been well described by a number of observers.§

Mr. Dunn showed that the material of the pipes, called "yellow ground" and "blue ground," whilst igneous in origin, yet contained large masses of the surrounding carbonaceous shales, often to such an extent as to constitute a breccia, whilst the beds in immediate contact with the "pipes" were abruptly bent upwards. All the included rocks showed traces of fusion, whilst in the outer portions of the pipes, where the blue ground is most heavily charged with carbonaceous shale, there is the richest yield of diamonds.

Professor Carvill Lewis has also drawn attention to the passage, at a depth of 600 feet, of the material of the volcanic pipes into two distinct types of rock. One only is diamantiferous, and is also crowded with fragments of carbonaceous shale, the non-diamantiferous type being free from inclusions, and is a typical volcanic rock.

The conclusions arrived at by Professor Carvill Lewis are stated as follows: "It seems evident that the diamond-bearing pipes are true volcanic rocks, composed of a very basic lava associated with a volcanic breccia and with tuff, and that the diamonds are secondary minerals produced by the action of this lava, with heat and pressure, on the carbonaceous shales, in contact with and enveloped by it."

Some support is lent to this theory by the researches of Professor Roscoe into the chemical composition of the "blue ground."** Noticing a peculiar smell somewhat

*Trans. Manch. Geol. Soc., Vol. XXII., p. 613.

†"Coal, its History and Uses," by Professors Green, Miall, Thorpe, Rucker and Marshall, 1878.

‡Sir H. de la Beche, Mem. Geol. Survey, Vol. 1., p. 217.

§J. Beete Jukes, "The South Staffordshire Coal Field," Mem. Geol. Survey, 1859, pp. 121, 122.

**"Origin of the Pennsylvania Anthracite," Bulletin Amer. Geol. Soc., Vol. V., pp. 39-70.

*Murchison, Verneuil, and von Keyserling, "The Geology of Russia in Europe and the Ural Mountains," 1845, Vol. I., p. 100.

†"Guide to the Geology of Scotland," 1844.

‡Since this paper was read, Mr. Smith has forwarded to me the proof sheets of a paper read by him before the Glasgow Geological Society on January 10th, 1895, upon the Craigman Mine. The title is as follows: "Charred Coal with Graphite, Craigman, New Cumnock."

§"On the New England Coal Fields of the United States."

**"Mineral Resources of the United States," U. S. Geol. Survey, 1892, p. 263.

††Professor A. E. Nordenskiold, "Account of an Expedition to Greenland in the year 1870," Geol. Mag., Vol. IX., 1872.

*Dana, "System of Mineralogy," 1892, p. 8.

†Dawson, "Acadian Geology," 2nd ed., 1868, p. 663.

‡Prof. H. E. Roscoe, "Diamond Bearing Rocks of South Africa," Proc. Manch. Lit. and Phil. Soc., 1884, p. 5.

§Prof. Carvill Lewis, "On a Diamantiferous Peridotite, and the Genesis of the Diamond," Report Brit. Assoc., 1886, p. 667, and Geol. Mag., 1887, p. 22.

**"Diamond-bearing Rocks of South Africa," Proc. Manch. Lit. and Phil. Soc., pp. 8-9.

like that of camphor, Professor Roscoe digested a portion of the material with ether, from which he afterwards obtained a small quantity of a crystalline aromatic hydrocarbon which burnt very easily with a smoky flame.

Professor Lewis has added to the abstract of his paper, which appeared in the *Geological Magazine*, a note stating that a similar association of volcanic and carbonaceous rocks has been found at other places.

In New South Wales, the diamond grounds lie near the junction of serpentine or basalts with carbonaceous rocks. At the Bingera diamond field, for example, a boss of eruptive serpentine is almost surrounded by carboniferous rocks containing coal seams. In Western America, the diamantiferous grounds are in close proximity to an area where serpentine and carbonaceous rocks occur together.

The evidence is fairly conclusive that diamonds have been formed in the areas mentioned, as the result of metamorphic changes induced in carbonaceous matter by the action of heat derived from adjacent igneous rocks which have penetrated the beds. In other cases where diamonds have been found in coarse sandstone and gravel, we may infer that their source was some area similar to that of Kimberly which was subjected to denuding agencies, and more or less destroyed.

It is well within the bounds of probability that as alluvial gravels are worked out in the search for diamonds, future prospecting will lead up to the original diamantiferous areas where an association of carbonaceous and igneous rocks may be expected to occur; indeed, this is what happened in the case of Kimberly.

The causes which have operated in the conversion of bituminous coals into anthracite have attracted many workers, and various theories have been put forward.

Metamorphism of bituminous coals into anthracite by intrusion of igneous rock is generally admitted, although it sometimes happens that the coal is simply charred, or converted into a friable dull earthey mass, as in the Staffordshire coal field.

The influence of earth-folds, earth-heat, and deep-seated igneous rocks is not so widely accepted, although these agencies have each been selected by various workers as affording the best possible explanation of the conditions which obtain in various areas.

De la Beche in attempting to determine the formation of the anthracite of South Wales,* showed that the bituminous seams changed so gradually into anthracite that it was difficult to mark one off from the other. In this field the passage into anthracite is towards the west, the best and purest occurring in Pembrokeshire, where the rocks have been most disturbed and folded. A similar feature had been noticed in the anthracite fields of Pennsylvania, U. S. A., by Professor Rogers, who sought to explain the metamorphism by accounting for the dissipation of the original gaseous contents of the coal, as the result of superheated steam and heat developed by the folding which the rocks had undergone.

But De la Beche in this country and Professor Stevenson in America, have shown that this theory is not wholly satisfactory. The former pointed out* that certain of the bituminous coals of South Wales had been more disturbed than the anthracites; for example, the bituminous coals of Volseter, in the Mendip Hills, being far more contorted than the anthracites of Glamorganshire and Carmarthenshire.

The latter has shown† that Professor Rogers' conclusions are not wholly correct for the Pennsylvania field, and that as in South Wales, certain bituminous areas are more folded and contorted than others which contain pure anthracite. As a more workable theory and as agreeing more closely with the facts of the Pennsylvania coal field, Stevenson has sought to explain the formation of the Pennsylvanian anthracites by supposing that they represent the oldest portions of the coal field, or the marshlands which first commenced to grow out from the old shore line over the shallows, and that being the oldest, they have undergone a more complete chemical change and greater loss of volatile compounds than is the case with the younger deposits of coal further west, which still retain their bituminous character.

By this theory, as I understand it, the loss of hydrocarbon compounds must be taken as indicative of the relative ages of the coal bed.

This argument would prove very useful as an explanation of the origin of graphite deposits so common in the older rocks, but I have not been able to find it capable of application outside the Pennsylvanian area. It does not seem satisfactory in such a coal as that of South Wales, where in a single seam there is a gradual passage from a bituminous coal to a perfect anthracite, unless indeed it can be proved that the most westerly portion of the seam was formed at an earlier period than the easterly. Though we cannot apply Prof. Stevenson's hypothesis outside the Pennsylvanian area, it is almost certain that the progress of chemical change in the course of ages, to which he draws attention, must always be reckoned an important factor in the ultimate passage of coal to a high state of carbon purity.

Dr. D. D. Owen‡ explained the formation of the undisturbed anthracite fields of Arkansas by supposing the existence of deep-seated igneous rocks giving off heated gases, which in their passage upward through the coal carried away the volatile hydrocarbons. A similar conclusion was also arrived at by Professor Hull for the Irish anthracites, and by Sir R. J. Murchison for the anthracites of the Donetz coal field in Southern Russia.

Prof. Lesley,§ taking up the question in its physical aspect, put forward the suggestion that the action of earth heat, due to the loading of the coal measures by overlying deposits, might have been adequate to drive off the gaseous constituents of the coal.

Where it can be shown that the loading to which the Coal Measures have been subjected can only be reckoned by thousands of feet, this supposition may be correct, but the difficulty often is in proving this overlying thickness of deposits. That a comparatively low heat, if long continued, is sufficient to convert a bituminous coal into anthracite has been proved experimentally. De la Beche mentions a case* in which bituminous coal was converted into anthracite by a very gradual application of heat. Dr. Lyon Playfair,† who afterwarde examined the specimens so produced, speaks of them as much like native anthracite. In damped down furnaces anthracite and coke may be produced, the former owing its origin to a lower heat than the latter.

*Memoirs Geol. Survey, Vol. I., p. 217.

†"Origin of the Pennsylvania Anthracite," Bulletin American Geol. Soc., Vol. V., 1893, p. 34.

‡Owen, "First Report of a Geological Reconnaissance of the Northern Counties of Arkansas," 1858.

§Lesley, "Second Geol. Survey of Penn., Second Report of Progress in the Laboratory" 1879.

In reviewing these various theories and seeking to apply them it becomes very evident that whilst any of them may be sufficient to explain the conditions of a particular case or area, none of them are held to satisfy all requirements.

In all cases anthracite is formed by the elimination of volatile hydrocarbons from the original bituminous coal, and since it has been demonstrated that a temperature lower than that required to coke the coal will, if long continued, be sufficient to effect the change, we may assume that where it can be proved that heat has been developed, whatever may have been the cause, it, and it alone, will accomplish the change. Cases, however, must have occurred where, by the formation of earth folds, intrusive dykes, and similar agents, considerable heat has been developed, only to be rapidly dissipated by the conductivity of the surrounding rocks, or by finding some avenue of escape, or even by acting more easily upon associated strata. An instance of the latter occurs at Craigman, New Cumnock, Ayrshire, where the clay shales which overlay the coal have undergone much more alteration than the coal itself, and partake very largely of the character of jasper.

Where a dyke-like mass has been suddenly injected into a coal bed, as in the South Staffordshire coal field, the great and sudden accession of heat has converted the adjacent layer of coal into a friable carbonized mass somewhat in the nature of a lampblack. The layer thus formed would act as a protecting layer to the rest of the coal by reason of its low conductivity, and little or no anthracite would be produced.

The conversion of bituminous coal into anthracite is, I believe, chiefly accomplished by heat, and as heat is developed in all manner of ways in the earth's crust, it is but natural that various heat-producing agents have been advocated from time to time as the sources of all anthracite formation. No statement has been put forward hitherto, so far as I am aware, of the stages of metamorphism of coal into graphite; but that graphite has been formed artificially in many ways, and in various manufactures and metallurgical operations, as a direct product of coal when subjected to great heat, is well known.

In the retorts of gas furnaces large quantities of graphite are deposited on the inner sides of the retorts from the gases driven off from the coal, and by the kindness of C. Nickson, Esq., I am able to lay before you several specimens of graphite formed in the retorts of the Manchester Gas Works. Graphite is not unfrequently formed in blast furnaces, where, under varying degrees of heat, coal has been seen to pass through the stages of burnt coal, anthracite, charred coal and coke, into graphite. This fact is of considerable importance as furnishing a clue to the metamorphism of coal into graphite in the earth's crust, and is probably paralleled by the series of changes induced in coal in the Ayrshire coal field.

Mr. Smith, of Monkredding, writes me that his observations of the Ayrshire coal field show that the changes which coal undergoes as it nears a trap dyke or an intrusive mass is as follows:

1. Charred coal (generally columnar, but sometimes massive, and often reduced to a black powder).
2. Anthracite (not inflammable, with a glittering surface).
3. Burnt coal (slightly inflammable).
4. Free coal (inflammable).

The coal near the intrusive masses in the South Staffordshire coal field appears to have passed through a similar series of changes, but has stopped short at the charred or coke condition. Some specimens of coal only a few inches in diameter obtained from this coal field seem to consist of a confused mixture of anthracite and compact charred coal.

The specimen of "graphitoid anthracite" from Worcester, Mass., U. S. A., kindly sent me by Professor Stevenson, of New York University, is very largely graphitic, so much so that it is difficult to say what was the stage immediately antecedent to the graphite. A portion of the specimen shows a few dull compact fragments which seem included in the general graphitic mass, and which bear a general likeness to the charred coal of South Staffordshire. From one specimen we cannot postulate that the same changes from anthracite to charred coal and then to graphite occur in the Worcester area of Massachusetts as at Craigman mine, but an inference that such is the case can at least be held.

The present condition of the beds in the case of the Craigman mine, Ayrshire, point to two intrusions of igneous material. By the first, the shale which lay upon the coal was lifted up and porcelainized, the coal being probably charred to some degree. The second intrusion took place along a plane dividing the coal and the basal portion of the first intrusive mass, which is now much decomposed. The overlying shales having been already porcelainized served to retard the loss of heat, the coal thus becoming subjected to a higher temperature than in the first case and for a much longer period, with an ultimate conversion into graphite. This theory is held by Mr. Smith, of Monkredding, and agrees so well with the facts that I see no reason why it should not be the correct one. The changes induced in the coal are exactly analogous to what is seen in blast furnaces, and can be demonstrated experimentally.

*Mem. Geol. Survey, Vol. I., p. 252.

† Lyon Playfair, "On the Gases Evolved During the Formation of Coal," Mem. Geol. Survey, Vol. I., p. 477.

For the artificial conversion of coal into anthracite we have already cited Sir H. de la Beche and Sir Lyon Playfair; for its further conversion into coke by the application of heat I may instance the effects of combustion in coke ovens and gas furnaces; and for the still further change of coke directly into graphite I would draw your attention to certain striking experiments of Henri Moissan, which are described in detail in the *Comptes Rendus*.*

Moissan found that a small crucible of very pure coke fitted with a lid of the same material was entirely converted into graphite by heating for *ten minutes* in the electric arc. That no fusion took place was proved by the lid of the crucible (which was also converted into graphite) being perfectly free in its place.

Further experiments with charcoal of sugar showed that the mass was entirely converted into graphite, whilst still retaining its form, and showed no traces of fusion even when examined with the microscope.

But even without these experiments there is clear evidence that when rocks containing carbonaceous matter as a constituent are subjected to heat metamorphism, the carbon is converted into graphite in the metamorphosed rock.

Rosenbusch, Brogger, Rudeman, and Sauer agreed in regarding the graphitic particles in the rocks of contact areas as having an original carbonaceous origin.

This fact has been proved by Messrs. Beche and Luzi,† who have most recently studied the question.

They state that the Upper Silurian clay slate and Kiesels Schiefer of Pirna and Kreischa are rich in particles of carbon, and that these rocks are converted into chiastolite slate rich in graphite and into graphitic quartzite, in the contact zone of the Dohna granitite and of the Weesensteiner hornblende-granitite.

Examples of chiastolite slate and of graphitic quartzite were taken by these authors and carefully examined, petrologically and chemically, and also compared with the unaltered Upper Silurian slates and Kiesel Schiefer, from which they had been undoubtedly derived. It was shown that the quartz of the clay slates and Kiesel Schiefer had been entirely recrystallized when the rocks passed into chiastolite slates and quartzite, with an increase in the size of the crystals. This recrystallization took place after, or at least contemporaneous with, the conversion into graphite of the particles of carbon.

The carbon particles in the unaltered slate are so excessively minute that they can scarcely be measured, and are usually under .001 m. m. in diameter; but in the metamorphosed rock they are represented by graphite particles which vary in size between .003 and .01 m. m., and rise as high as .02 m. m.

Not only do large crystalline aggregates of graphite occur in the chiastolite slate and graphitic quartzite, but isolated crystals having a well defined hexagonal outline.

Messrs. Beche and Luzi seem to have clearly demonstrated by both petrological and chemical means what had previously been asserted by Rosenbusch and others, and as a result of their work it may be taken for granted that when a sedimentary rock containing carbon is metamorphosed, the carbon is converted into graphite.

A consideration of the foregoing facts shows that, whether by artificial means or by natural means, the conversion of bituminous coal into graphite is by well defined stages, by an anthracitic condition being first reached, which gives place to coke, and that in turn to graphite.

Certain researches of Moissan, to which we have not alluded, but which are dealt with in his paper, seem to show that when carbon is vaporized and afterwards condensed, graphite always results,, and it may be that in some of the oldest known rocks volatilization of the carbonaceous matter has first taken place, and afterwards condensation in veins and pockets as graphite.‡

The few known cases in which eruptive rocks have penetrated carbonaceous shales have not yet yielded any clue as to the mode of origin of the diamond, and we may safely assert that no theory at present propounded for coal metamorphism throws any light upon it.

Moissan is of opinion that in the case of carbon subjected to high pressure and heat, increased density ensues, and the diamond results, and claims to have formed diamonds under these conditions. He says: "In my ingots of iron refrigerated in lead I have produced small diamonds presenting an appearance of an elongated drop, as it is sometimes met with in nature. We know that there are found at the Cape and in Brazil diamonds possessing no trace of apparent crystallization, and have rounded forms like those which a liquid might assume if kept in the midst of a pasty mass. Carbon under pressure might, therefore, take a liquid state, and solidify like water, presenting either a confused mass of crystals or taking a rounded and amorphous figure."

The association of carbonaceous shales and a diamantiferous area at Kimberly are, however, so remarkable that all who have worked upon the subject have expressed a belief that in some way the formation of diamonds has been due to the action of erupted material upon carbonaceous matter.

*Henri Moisson, "The Evaporation of Carbon," *Chemical News*, December 21st, 1894, Vol. LXX., and *Comptes Rendus*, Vol. CXIX., p. 776.

†R. Beche and W. Luzi, "Ueber die Bildung von Graphit bei der Contact Metamorphose," Neues Jahrbuch fur Mineralogie, Geologie, und Paleontologie; Jahrgang, 1894, p. 28.

‡Prof. Heddle, of St. Andrew's University, informs me that during the course of his studies of the graphite in Scottish rocks he has never seen a case where a true anthracite was converted into graphite and that more usually the latter arises from heat acting upon bituminous shales than upon coal.

The Goyne Pump Works, of Ashland, Pa., has recently completed, for the Delaware and Hudson Canal Company, for one of that company's collieries at Plymouth, a duplex compound condensing pump. Its high pressure cylinders have a diameter of 28″ while the low pressure cylinders are 42″. The plungers are 13″x36″. The Goynes have also recently shipped to the Penn Manor Shaft Co., at Manor Station, Pa., one of their Standard (24″x10″x36″) mine pumps.

ELECTRICAL MINING MACHINERY.

Description of the Electrical Machinery at the Scott Haven Mines, and Its Success.

Written for THE COLLIERY ENGINEER AND METAL MINER.

One of the most interesting electrically operated coal properties in America is that of the Youghiogheny River Coal Co. at Scott Haven, Pa. The mines of this company in which the different machines driven by electrical power are installed are scattered over a considerable extent of territory and lay on both sides of the Youghiogheny river.

The power house is located on the east side of the river contiguous to the line of the Baltimore & Ohio R. R. It was formerly a bonded warehouse and contains not only the machinery, but also the stores and offices.

The boiler plant consists of three $60'' \times 18'$ tubular boilers, each containing fifty-eight 4'' tubes. Each boiler is coaled through a chute, is independent and has its own stack. They were built by the Union Iron Works of Erie, Pa. Water for these boilers is pumped by a Downie deep well pump from a well 130' deep and such water as is not immediately used is stored in tanks.

The engine room is 74' long and 54' wide and is separated by a brick wall from the power house. The engine plant consists of three automatic engines each $15'' \times 16''$ cylinders with 72'' fly wheels running at 240 revolutions per minute. Each engine is belted to a four pole, 650 revolution 100 K. W. General Electric Co. generator wound for 500 volts and over-compounded for 10% loss in the line. The engines and dynamos are erected on brick foundations. The current from the generators is carried under the floor to the switch-board over heavily insulated cables laid on porcelain insulators.

The switch-board is of the skeleton type divided into two parts; one for the generators and one for the feeders, on a plan similar to that used in the ordinary electric railway stations. The generator board carries three automatic circuit breakers, three circular Weston ammeters, three main double pole double throw switches and three field rheostats. The volt meter is carried on a bracket on the side. The arrangement of the switchboard is such that the plant may be run under the most economical conditions and every precaution is taken against stoppage in its operation. Two sets of circuits are run, one of which is grounded for haulage work and the other, metallic, for the fans, coal cutters, etc. Any machine may be run on either the metallic or grounded circuit and any two or three may be run in multiple on either circuit. The feeder switch-board carries an automatic circuit breaker for each of the haulage circuits and a double pole switch for each pump circuit, fan circuit and the coal cutter circuit; and a double pole switch for throwing the metallic and grounded bars into multiple. Lightning arresters protecting the generators are placed behind the switch-board.

From the power house the circuits for No. 1 mine are run on poles to the mine mouth. This mine is about 900' from the power house and the circuit is used to drive fans, pumps, locomotives and coal cutters. The fan is a Capell exhaust fan 8' in diameter and 3½' wide with single inlet. It is driven by a belted 25-horse-power multipolar, moderate speed motor running at 650 revolutions per minute. The distance from the generator station to this fan is such that the loss of current is so unimportant that the mine management has not taken it into account in their tests, the results of which, given us by Mr. W. S. Gresley, superintendent, were as follows:

Revolutions of fan	268 per minute
Cubic feet of air produced	85,000 per minute
Water gauge	1.1 inches
Horse power in the air	14.7
Horse power in motor	17.25
Percentage of useful effect of fan on motor	85.2 per cent.

There is another Capell fan in use in this mine which, at the time the tests were made, was run by a temporary steam engine at 100 revolutions per minute. The fan is 12½' in diameter and 5' wide, single inlet. The volume of air produced was 80,000 cubic feet per minute; the water gauge was not taken. The maximum duty of this fan is 150,000 cu. ft. of air per minute at 7'' water gauge. With the new 50 horse-power motor which the General Electric Co. attached to this fan its output is on the basis of 190,000 cu. ft. of air per minute at 1'' water gauge, but with 50 horse power in the motor the water gauge will be much higher and the volume lower as the air road from the fan to the first split is so small that water gauge will be produced at the expense of volume of air.

All the coal cutting in this mine is done by five Jeffrey chain coal cutters. The mine is also provided with a Knowles triplex pump 6½'' x 8'' driven by a 7½ horse-power multipolar motor. The pump, motor and rheostat are mounted on an iron truck so as to be run over the track from place to place in the mine.

An electric locomotive is in operation in this mine with a length of haul a little over 1½ miles. The grades vary from 1% against loads to 0.25% in their favor. The track is laid with 30 pound rails and has a gauge of 43½''. The trolley wire is hung in the regulation mining style. The pump and haulage circuits are all grounded for the return.

The fact that the various mines are separated from each other by the river introduces a novel feature into the installation and illustrates the flexibility of electric power transmission. For each of the other mines in the Youghiogheny company's system current is carried under the Youghiogheny river by heavily insulated cables to a small cable house forming the center of distribution for the lines running to the mines on the west side of the river.

In No. 4 and the Southwest mines electricity is applied to pumping purposes only. The pumps are triplex pumps similar to those in No. 1 mine, and are driven by two multipolar slow speed motors of 10 horse-power and 7½ horse-power, respectively. These pumps are about 8,000 feet away from the power house.

In the Pacific mine the haulage is effected by a locomotive having a draw-bar pull of 2,500 pounds, with a length of haul of about 5,000' underground and 800' on the surface. This mine also contains a pump similar in size to that in No. 1 mine which is driven by a 7½ horse-power motor located about 16,000' from the power house. A 30 horse-power motor for driving a Capell fan is erected about 1,000' feet beyond the pump. This fan is a good sample of a small ventilating installation under conditions which with other methods would be both difficult and costly, and is of an efficiency (in transmission, certainly) not hitherto attained. The fan is 8' in diameter and 3½' wide, with a single inlet, and in other respects is the same as the fan first described. The power is carried across the Youghiogheny river into No. 1 mine through a labyrinth of active and old workings to the foot of a shaft 120' deep, thence up the shaft to the surface, where the fan and motor are erected. The first hour this plant started it ventilated the mine, the fan giving 61,800 cubic feet of air per minute on an output of 13 horse-power by the motor. In the forceful language of the mine foreman in reporting the start to Mr. Gresley, "She went off slick as grease."

Subsequent tests show the fan to give 65,000 to 70,000 cu. ft. of air per minute at 1.5'' water gauge (for 65,000 cu. ft.), the quantity varying with the opening and closing of doors and other conditions in the two mines. The results of the test in detail are as follows:

Speed of fan	200 revolutions per min.
Volume of air per minute	65,000 cu. ft.
Water gauge	1.5''
Horse-power in the air	15.4
Horse-power at motor	20.1
Horse-power at generator	22.1
Percentage of useful effect of fan as compared with motor	76.5 per cent.
Percentage of useful effect of fan as compared with generator	69.73 per cent.

From the above statement it will be seen that the current loss for 3½ miles, the distance the fan is away from the power house, is only 6.77%. In this connection it will be interesting to compare a German installation of the Capell fan with this Scott Haven plant. The Bonifacius plant, Kray, Westphalia, was erected about three years ago and a test was made by eminent mining engineers of which the following were the results. The fan was 10' in diameter and 4½' wide.

Speed of fan	190 revolutions per min.
Volume of air produced per minute	89,000 cu. ft.
Water gauge	2.4''
Percentage of useful effect of fan as compared with engine indication	60 per cent.

The engine used in this case was of superior finish and high speed, but the difference between the indicated and brake horse-power is not stated.

In the new steel tipple at No. 1 mine a 7½ horse-power motor drives a revolving screen and runs an emery wheel for sharpening bits for the coal cutters, etc. The installation of electricity in this mine has proved of more than considerable benefit from every point of view. A fair idea may be obtained of the economical value of electric haulage from the statement that the two locomotives have displaced eighteen mules and their drivers and the four pumps, which take only a small share of the attention of three separate men, are doing the work formerly performed by ten men, four mules, two steam boilers and two steam pumps, and they are doing it more efficiently.

The entire electrical apparatus used in the power house and in the mine, with the exception of the coal cutters, is of the General Electric Company's manufacture. Within the past three years this company has perhaps done more to develop electrical apparatus for use in mining work than any other electric company. It has over 50 of its mining locomotives in use at different mines in the country, as well as pumps, hoists, ventilators, coal cutters, drills, etc., and all are working satisfactorily and economically.

The Capell fans were put up under the supervision of Mr. Wm. Clifford, Mining Engineer, Pittsburg, Pa., who is Dr. Capell's representative in this country.

STEAM SPECIALTIES

At the National Electrical Exposition, New York City.

In arranging the great exhibition of electrical machinery and appliances, The National Electrical Exposition Co., of New York, decided that such an exposition would not be complete without a steam boiler plant supplied with first-class appliances so as to show a strictly modern plant.

The arrangement for supplying the boilers with fuel was constructed by the C. W. Hunt Co. The coal after being dumped at some distance from the boilers in the rear is taken by the C. W. Hunt coal conveyor and carried along the side and a little past the front of the boilers where it is lifted to a point near the ceiling of the boiler house from whence it is delivered through tubes to the hoppers of the stokers; from that point it is fed uniformly down inclined grates, burning on its way, and reaching the foot of the grates as ash. The Hunt conveyor next takes the ashes and carries them back to the dumping place somewhere in the rear of the boiler, dumping them there automatically.

The boiler feed water is supplied by a boiler feed pump constructed by Henry R. Worthington and is electrically driven. The pump is of the "steeple pattern" and combined with its motor presents a novel and elegant appearance.

The pressure carried by the boilers is 125 pounds. This pressure is carried along the main steam pipe to a point just beyond the first engine; there it is reduced by a Foster reducing valve manufactured by the Foster Engineering Co. of Newark, N. J., to 90 pounds, from which point it is carried to all the other engines on exhibition. The Foster Engineering Co. also exhibits a new automatic safety stop valve to be placed in the main steam pipe near the boiler. This valve will instantly and automatically close in case of a rupture in the steam pipe or the breaking of any of its fittings. By this means the steam in the boiler will instantly be stopped from rushing into the pipes and all such fatalities as have recently occurred due to ruptured steam pipes will be avoided. Another valuable feature used in connection with this automatic stop valve is found in a pipe leading from it, containing a quick closing lever gate valve. When this is opened quickly the main valve closes instantly, and thus the whole steam supply can be cut off from the main steam pipe at an instant's notice.

The visitor cannot fail to be struck with the beautiful finish of the water tube boilers. The fine, smooth, black finish contrasts strikingly with the nickel work and is produced by the use of Dixon's graphite boiler front paint, made by the Joseph Dixon Crucible Co., of Jersey City, N. J., whose exhibit is in the neighborhood of the boilers.

Among the engines used at this exposition is one of the well-known Weston engines which compares splendidly with any competitor exhibited.

The exhaust from all of the engines is passed through a Goubert feed water heater and then sent through spiral riveted exhaust pipes placed outside the building to a point above the roof. All the feed water used will pass through this heater, thus supplying the boilers with a bountiful supply of water heated to nearly 212 degrees.

The entire plant is so simple and safe in operation that a woman has been put in charge of it to show conclusively that if the steam user will adopt the modern type of appliances and equip his plant in an up to date manner throughout its operation becomes so simple that a woman can operate it as well as the most expert and strong fireman.

SUPERIOR GRAPHITE PAINT.

We have received from the Detroit Graphite Manufacturing Co., of Detroit, Mich., a piece of a boiler stack which had been in use for three years after being painted with *one coat* of superior graphite paint. The piece of iron, after this severe service looks as if it had been but recently painted. A piece of a 3½ inch boiler tube which had also been used three years after being painted with one coat of superior graphite paint looks as perfect as if it had been cut off of a new tube. The paint on this piece of tube is still bright and fresh.

A piece of canvass painted on both sides with the same paint accompanied the piece of stack and piece of tubing. The canvass is similar to old sail, or brattice cloth. The paint makes the canvass perfectly water proof and protects it from the action of mine water which soon renders ordinary brattice cloth rotten. This paint has been proven a wonderful protector of iron exposed to the action of acidulated waters and gases. As an example of the resistance of this paint to the action of acids and alkalis, the makers inform us that they have subjected it to the follow tests:

Pieces of iron painted with superior graphite paint, which are now being tested, have been dipped in muriatic, sulphuric and oxalic acids and then allowed to dry with the acid on the them for 19 days, at present writing, without showing a particle of damage to the paint. The longest time which other paints withstood these conditions without injury was 24 hours, when they were entirely destroced. Superior graphite paint has also been immersed in ammonia and sal soda for 19 days, in coal oil for several weeks, and in strong brine for six years without showing injury. They have also submitted pieces of iron painted with superior graphite paint to 24-hour tests in boiling alcohol, boiling beer, boiling brine and boiling sugar and water without the paint showing any injury. Red lead paint subjected to boiling alcohol stood 15 minutes; to boiling beer, 30 minutes; to boiling brine, 25 minutes; to boiling sugar and water, 15 minutes. Superior graphite paint has also stood in cold soft soap 24 hours without damage, while other paints stood for one hour only. These are extremely hard conditions, and, except possibly some of the simpler ones, it is seldom that a paint is ever subjected to them.

A paint which will stand such tests is of value to every mine manager, and we advise all such to give it a trial. Full particulars as to prices, etc., will be cheerfully furnished on application to the Detroit Graphite Manufacturing Co., Detroit, Mich.

Improved Car Door Fastener.

The Watt Mining Car Wheel Co., of Barnesville, Ohio, has recently had patented a door fastening for mine cars which possesses such merits as to make it exceedingly popular. It is simple in construction, quick in operation, and easily applied either to a new car or an old car having a door swung from the top. It will not easily get out of repair, as it is so constructed that it allows the door to swing freely, and there is no danger of it striking either the sides or the bottom of the car.

An illustration of this improvement is shown in the advertisement of the Watt Mining Car Wheel Co. on another page.

The Watt Co. is on the lookout at all times for any practical and useful improvement in the construction of mine cars. They are the exclusive manufacturers of the "Watt Self-Oiling Mine Car Wheel," and as they make a specialty of building mine cars for any gauge and of any capacity, they are prepared to do satisfactory work and get it out on reasonable terms and at short notice.

Bellis Mine Collars.

Mr. W. L. Bellis, sole manufacturer of the Bellis Mine Collar, so well known to many mine managers throughout the country as an excellent preventive of sore shoulders on mine mules, has just issued a convenient little catalogue of his collars and general harness.

The Bellis collar has made an enviable record in mines in all parts of the continent. They not only prevent sore shoulders but cure them as well. These collars are now regularly used by fully forty of the largest coal mining concerns in America, and have been thus introduced in several hundred of the most important mines.

CLASSIFICATION OF BITUMINOUS COALS.

What Constitutes Good Steam, Gas, Smithing and Coking Coals.

Written for THE COLLIERY ENGINEER AND METAL MINER by Baird Halberstadt, Min. Engr., Pottsville, Pa.

The question is often asked by young mining engineers and others interested: "In what particulars do soft coals differ chemically and physically, so that a coal which is excellent for a specific purpose will fail to give satisfactory results, should it be put to other uses." For example, why is it that the Clearfield or Pocahontas coals are superior to either the Connellsville or Westmoreland coals for steam generation, while the former for coke and the latter for gas manufacture are superior to either the Clearfield or Pocahontas coals?

Deservedly or undeservedly, the coals of certain regions have established for themselves high reputations, and have for a long period continued, notwithstanding the liveliest competition, to maintain them.

No region can long continue to monopolize a special trade unless its coals possess in a greater degree than do others, the essential characteristics required when put to special uses. So firmly indeed have some regions established reputations for their coals for certain uses, and so high do they stand in "Trade" circles that they have been accepted as standards, and as coals from newly opened fields approach or recede from, in chemical composition, these standards, their values are determined, *i. e.*, so far as the "Trade" is concerned. For instance, when a new coking coal field is developed, almost the first question asked is, how does the coal compare with Connellsville? Again, when new coals are placed on the market, for which are claimed especial value for use in generating steam, buyers will ask, how does this coal compare with Clearfield and Pocahontas coal?

In view of this, for it is beyond question that these regions have so firmly intrenched themselves that they seemingly cannot be dislodged, we must, for the present, at least, and until a better plan be evolved, acquiesce in this judgment. Assuming this to be correct, the question arises, why are they better? and through the possession of what peculiar characteristic or characteristics, are these coals made more valuable for specific purposes, than others?

In this paper will be considered coals for steam generation, the manufacture of gas, smithing purposes and the manufacture of coke. For each of these purposes, certain coals have achieved enviable reputations and continue to maintain them. They are as follows:

For steam purposes—Clearfield and Pocahontas.

For the manufacture of illuminating gas—Westmoreland and Youghiogheny.

For smithing purposes—Broad Top and Bradford Tioga.

For the manufacture of coke—Connellsville.

At the very outset, the requirements of each subject must be considered—and these it will be noticed differ widely.

What then are the requirements to be considered and what essentials must be possessed by a coal to make it more valuable for generating steam than others?

One of the best answers, if not the best, to this question, was given by the late Prof. Henry Darwin Rodgers, state geologist, in Vol. II, page 998 *et seq.*, "Geology of Pennsylvania." From it have been compiled the following:—

First—It should possess a high, absolute evaporative power.

Second—It should at the same time, as far as compatible with the foregoing property, kindle readily and burn with great celerity, generating a large body of steam in a short time.

Third—It should be readily managed and steady in combustion, and to this end its ashes or earthy matter should tend as little as possible to choke the draft of the grate by fusing, even at an extreme heat, into an adhesive clinker.

Fourth—The fuel should be free from any excess of incombustible matter, as this, all other things being the same, will materially impair its efficiency, and its ashes should produce but little clinker.

Fifth—It should be exempt from any considerable amount of sulphur, for this tends to corrode the flues and is otherwise detrimental.

Sixth—Volatile matters should not exist in any greater amount than will suffice to give great rapidity of combustion to the fuel. Any larger proportion is at the expense of its heating power.

Seventh—For certain uses it is important that a coal should unite with a high evaporative power such a degree of density and structure as will enable it to contain a relatively large amount of carbon in a given space. This compatibility of being economically stowed or packed away is a point of daily increasing consideration.

Eighth—It is likewise desirable that a coal should possess sufficient tenacity in the lump to bear the abrasion incident to its transportation without serious reduction to fine coal.

A study of the chemical analyses of standard steam coals seems to indicate that the best results have been obtained from coals wherein the percentages ranged as follows:—

	Per cent.
Fixed carbon	67 to 74
Volatile matter	17 to 22
Sulphur	0.5 to 0.9
Ash	5.0 to 8.0

CLEARFIELD COAL.

The following analyses of Clearfield, Cumberland and Pocahontas coals, all considered *standard*, made by Mr. Andrew S. McCreath, which is sufficient guarantee of their entire reliability, may be taken as typical:—

No. 1 sample taken from thirteen cars at Greenwich, Philadelphia.

No. 2 sample taken from five cars at Canton, Baltimore.

No. 3 sample taken from seven cars at Canton, Baltimore.

	(1)	(2)	(3)	Ave. (1, 2 and 3)
Water	1.528	1.166	1.654	1.180
Volatile matter	22.122	22.299	22.081	22.167⅓
Fixed carbon	70.051	67.558	70.199	69.270
Sulphur	.652	1.422	.726	.933⅓
Ash	5.825	7.555	5.900	6.443⅓
	100.000	100.000	100.000	100.000

CUMBERLAND COAL.

No. 1. Sample taken from coal supplied to the Shenandoah Valley Railroad company.

No. 2. Sample taken from six cars at Greenwich, Philadelphia.

	(1)	(2)	Ave. (1 and 2.)
Water	.912	.971	.968
Volatile matter	18.105	19.776	19.120½
Fixed carbon	73.154	72.263	72.707½
Sulphur	.806	.769	.787½
Ash	6.695	6.129	6.107½
	100.000	100.000	100.000

FLAT TOP (POCOHONTAS) COAL.

The average of 10 analyses of this coal is as follows:

Water	0.694
Volatile Matter	18.832
Fixed Carbon	74.066
Sulphur	.761
Ash	5.647
	100.000

The average of 8 analyses of coal taken from the No. 3 (Pocohontas) bed shows:

Water	0.628
Volatile Matter	18.750
Fixed Carbon	73.406
Sulphur	.792
Ash	6.388
	100.000

In writing upon this subject Mr. McCreath says: "While the analysis of a coal affords a fair opportunity of judging of its character as a steam coal, yet there are so many points connected with its physical structure and coking qualities which an analysis cannot show, that a practical testing under boilers is of the highest importance."

The requisites of a good coal for the manufacture of illuminating gas are:

1. That the percentage of volatile hydro-carbons should be at least 33 per cent. Above this amount, quality, rather than quantity, should be sought for; *i. e.*, richness in illuminating properties.

2. That the percentage of sulphur should be low, say from 0.5 to 0.8 per cent.

3. A low percentage of ash, say from 3 to 6 per cent.

4. That it should yield upon distillation from 75 to 85 candle feet per pound.

5. That it should leave, after the extraction of the volatile matter, a firm, bright, merchantable coke.

6. That it should be strong enough to bear transportation well, for long distances, without serious waste by reduction to fine coal.

In his brochure on the gas coals of the United States, read before the convention of the American Gas Light Association, in Savannah, Mr. H. C. Adams, of Philadelphia, says:

"The essentials of a good gas coal are a low percentage of ash, say five per cent., and of sulphur, say one-half of one per cent., a generous share, say thirty-seven to forty per cent. of volatile matter, charged with rich illuminating hydro-carbons. And it should yield under present retort practice, eighty-five (85) candle feet to the pound carbonized. It should be sufficiently dense to bear transportation well so that when carried long distances, it may not arrive at its destination largely reduced to slack or fine coal of the consistency of sand. And it should possess coking qualities that will bring from the retorts, after carbonization, about sixty per cent. of clean, strong, bright coke.

The following table showing the analyses of some of the principal gas coals will prove interesting and valuable for reference:

ANALYSES OF PENNSYLVANIA GAS COALS.

No.	Water.	Volatile Matter.	Fixed Carbon.	Sulphur.	Ash.
1	1.427	37.521	54.921	.713	5.418
2	1.310	37.100	55.004	.656	5.950
3	1.560	39.185	54.372	.643	4.260
4	1.780	35.360	59.290	.680	2.890
5	1.280	38.105	54.383	.792	5.440
6	1.490	37.153	58.193	.678	2.566
7	1.020	33.205	63.314	.861	3.280
8	1.070	35.515	56.458	2.257	4.700
9	1.540	37.805	56.762	1.101	2.990
10	1.570	38.275	54.720	1.325	4.090
11	1.350	39.645	48.592	1.228	9.265
12	1.120	34.500	59.050	1.550	4.000
13	1.400	32.400	63.011	.639	2.450
14	1.600	30.700	63.791	.639	3.270
15	1.490	29.220	65.022	.608	3.670
16	1.430	31.940	62.100	.532	3.900
17	1.415	32.435	61.930	.975	3.215

Nos. 1, 2 and 3 are of coals mined by the Westmoreland Coal company; Nos. 4, 5 and 6 are of coals mined by the Penn Gas Coal company; No. 7 is of coal mined by the Greensburg Coal company; No. 8 is of coal mined by Saltsburg Coal company; Nos. 9, 10, 11 and 12, coals from Jefferson county; Nos. 13, 14, 15, 16 and 17, coals from Reynoldsville region.

The requirements of a good coal for smithing purposes are that:

1. It should possess a high heating power.

2. It should be free from sulphur, or, if any, a very small percentage.

3. It should possess sufficient coking qualities to form an arch, or vault, on the forge.

4. The percentage of ash should be small.

The first requirement means a high percentage of fixed carbon.

A high percentage of sulphur is not only ruinous to the iron, but prevents good welding. The percentage of sulphur should never exceed 1 per cent. Coal containing but one-half of 1 per cent. would be better.

The advantages afforded by the third requirement are many, among them may be mentioned:

1. Its economic importance in saving a large amount of fuel, the interior of the pile only being in a state of combustion.

2. By concentrating the heat upon the iron to be wrought; the arch over the base of the fire is practically an oven, and in consequence there is but a slight loss of heat. It also affords protection to the smith.

3. The coke forming the arch, when broken down, makes a superior fuel for fine welding.

The following table exhibits analyses of standard Pennsylvania smithing coals:

No.	Water.	Volatile Matter.	Fixed Carbon.	Sulphur.	Ash.
1	.715	22.250	70.518	1.459	5.058
2	.615	17.935	76.503	.602	4.345
3	.800	18.535	77.112	.573	2.920
4	.730	17.910	75.239	.656	5.665
5	1.465	19.741	68.974	.686	9.134

Nos. 1, 2 and 3 are of Cambria county coals.

No. 4 is of coal from the Broad Top region.

No. 5 is the average of eight analyses of Blossburg coal.

Upon the subject of coking coal much has been written, but the question as to why some coals coke and others do not has not yet been satisfactorily answered. Neither has the question as to the percentage of volatile matter necessary to complete the coking, without the expenditure of any of the fixed carbon, been definitely settled. Twenty years ago John Fulton, then, as now, the best authority upon the subject in America, said (Report *L*, Appendix *A*, Geological Survey of Pennsylvania): "It is evident that the calorific power of coke is derived from its carbon, and hence the purest coke will produce the greatest heat. This requirement of pure dry coke is more evident when it is considered that all foreign matter and moisture not only do not contribute heat, but require the expenditure of it in disposing of the extraneous matter in slag and vaporizing the moisture. It is manifest that the character of the coke is determined *by the quality of the coal used*, and the latter should receive very careful examination before expending largely in plant for coking. The first requirement in the production of good coke is a pure bituminous coal—coal having small quantities of ash, sulphur and phosphorus.

"The second requirement is that it contains a sufficient proportion of volatile or gaseous matter to supply the necessary heat in coking without the expenditure of carbon.

"And, thirdly, that the coal produces a coke of sufficient tenacity to sustain, without crumbling, the burden and blast of the furnace, and to inherit *an open cellular structure, to facilitate its impregnation and solution by the carbonic acid gas in the furnace.*"

He further states that "ordinary analyses fail to indicate the essential qualities of a good coking coal. They are highly useful, however, in exhibiting the carbon, ash and sulphur, thus clearly indicating the strength and purity of the coal. The only sure method in the determination of the adaptability of coal for coking, is to have a quantity of it made into coke, and a study of its physical and chemical properties carefully made."

As has been said before, the coal mined from the Pittsburg bed in the Connellsville basin of Pennsylvania is considered the *standard* coking coal of America, and as a coal nears or recedes from it in chemical analysis or physical test, its value is determined. This concession may be said to be general, but there are not wanting those who assert that Pocahontas (Flat Top) coke is equally as good, if it be properly made. For comparison, analyses of typical specimens of each coal are given:

	Connellsville.	Pocahontas.
Water	1.260	.694
Volatile Matter	30.107	18.832
Fixed Carbon	59.616	74.066
Sulphur	.784	.761
Ash	8.233	5.647
	100.000	100.000

Upon examination it will be found that the percentage of fixed carbon is greater by 14.450 per cent., in the Pocahontas coal. It also has less sulphur and ash than Connellsville. These are all in its favor. In the matter of volatile hydrocarbons, however, it is deficient, Connellsville possessing over 11 per cent. more of this highly important constituent. Experiments have demonstrated that the loss of carbon in coking amounts, in the Pocahontas coal to 20 per cent., while in the Connellsville coal it is but 8 per cent. under like conditions. Pocahontas coal, as shown by chemical analysis, approaches the coals of the Allegheny mountain district of Pennsylvania rather than the Connellsville. From the foregoing it may be said that the volatile matter should be between 18 and 32 per cent. and that the composition of this has much to do with the character of the coke.

A difference of 14 per cent. of volatile matter in two coals is a wide one, yet here we find good cokes being made from each.

The percentage of sulphur should not exceed 8-10 of 1 per cent., while the percentage of ash should not exceed 9 per cent., the lower the better in both cases.

The question of cellular structure of the coke is of great importance and should receive the most careful consideration, not only as to number of cells, but also as to the strength of the material forming the walls thereof. For reference the following table is appended: charge and in the proportion of ore to coke, without giving away.

This improvement in the physical quality of the coke is accompanied by a further improvement in its chemical

Table Showing the Physical and Chemical Properties of Standard Connellsville Coke.

LOCALITY.	Grammes in One Cubic Inch.		Pounds in One Cubic Foot.		Percentage.		Compressive Strength per cu. in. (½ Ultimate Strength).	Height of Furnace Charge Supported Without Crushing.	Order in Cellular Space.	Hardness.	Specific Gravity.	CHEMICAL ANALYSIS.					
												Fixed Carbon.	Moisture.	Ash.	Sulphur.	Phosphorus.	Volatile Matter.
Standard Connellsville	Wet.	Dry.	Wet.	Dry.	Coke.	Cells.											
Forty-Eight hour coke	14.02	20.95	53.41	79.81	66.92	33.08	249	100	1	3.5	1.500	87.46	0.49	11.32	0.69	0.029	.011
Seventy-two hour coke	12.46	20.25	47.47	77.15	61.53	38.47	284	114	1	3.5	1.500						

COKE OVEN CONSTRUCTION.

Its Effect on Coke, With Special Reference to Semet-Solvay Ovens.

By R. M. Atwater. Read Before the Society of Engineers of Western Pennsylvania.

Prof. J. P. Leslie describes the well known Pittsburg vein of coal as follows:

"The Pittsburg region is an outspread of the Pittsburg coal-bed, 50 miles long by 50 miles wide, within the limits of the state of Pennsylvania. An average of eight feet in thickness for the whole region looks like a fair one. This gives 8,000,000 tons per square mile, and there are 2,500 square miles. Allowing 50 per cent. of the area to be interval, and 50 per cent. for pillars and bad mining, we may set down this coal, available for market in the future, at 5,000,000,000 tons.

On this basis, 2% of the Pittsburg coal is contained in the Connellsville vein, counting it all as standard, and not over 1% of the high grade standard coking coal; yet this 1% of Pittsburg coal yields 75% of all the coke made in Pennsylvania, over 8,000,000 tons in 1895.

The object of my paper is to offer methods of coking the Pittsburg coal, which will enlarge the boundaries of the standard coking coal to all of the Pittsburg coal fields that bear coal of standard chemical composition. The available coal left in the Connellsville field is estimated to produce 70,000,000 tons of coke, which, at the 1895 rate, will last 10 to 12 years. It is, therefore, only a question of a few years when other coals must be used, especially if the consumption of coke increases as it should increase, and the United States produce coke for the whole western hemisphere. There is, therefore, in the broad view of the question, no controversy between the Connellsville beehive oven and the retort oven. The existing ovens will have completed their useful life before the adjacent coal is exhausted. So, without sacrifice, they will disappear, and the new construction will take the form of the retort oven. It is this gradual and economical merging of the old method into the new which I desire to present and advocate.

The beehive oven makes no provision for the physical improvement of the coke. It is a broad, shallow basin, in which the coking follows out its own natural course. So far as the quality of the coke depends upon the oven, it is as primitive and unimproved a construction as when it was first devised. Consequently, the beehive oven is a happy-go-lucky oven, and in the lottery of its application the prize fell to the narrow and limited Connellsville valley, or, more strictly, to the middle of this valley, for both the north and south end are not of equal quality with the so-called "standard coke."

In this fortuitous application of the beehive oven, great regions of coal of equal chemical purity with Connellsville have lain dormant, or even sold at lower prices, because they did not make hard coke. If this one lacking quality of structural strength can be added to the coke, it will bring areas of coal land 10 times as large as the Connellsville field up to the Connellsville grade for coke. This will add 25% to the value of such fields.

BEEHIVE AND RETORT OVENS COMPARED.

In the beehive oven a shallow basin 12 ft. in diameter is filled with coal to the depth of 24 inches. As it gradually fuses into coke, the mass swells to a height of about 30 inches, it, on quenching, it falls back to the original bulk, it makes a hard coke. If it does not, it makes a soft coke. This is the apparent difference between the Connellsville coke and the coke from the Pittsburg vein.

Comparing this operation in the retort oven, which is a narrow chamber about 18 inches wide and six feet high, when the coking coal swells it cannot expand. It is compressed laterally between the narrow oven walls, and vertically by the overlying weight of over five feet of coal. The result is that the coke which is soft when coked in beehive ovens is hard when coked in retort ovens.

Further, the hydro-carbon gases, escaping through the mass of the coke in the beehive oven, form vertical passages or cells, and make their way in channels like the cells in a cornstalk, or other endogenous plant. These correspond to the cells of the coke structure. As they are parallel to the lines of pressure of the overlying coal, they have free course, and assume their full size. On the other hand, in the retort oven, the volatile gases pass off first horizontally from the sides of the oven, and uniting in the central part of the mass, pass up to the outlet of the oven through a middle line of cleavage. The whole weight of the overlying mass of coal presses upon these passages vertically, and so compresses the cells, and adds to the density of the coke. The result is, therefore, clearly evident that the retort oven adds density and structural strength to the coke. It will, therefore, carry a heavier burden in the furnace, both in actual height of composition. The three characteristic impurities of coke are sulphur, phosphorus and excess of ash over that required for structural strength. In the beehive oven, not only is all the surplus volatile wasted, but there is a greater or less destruction of the fixed carbon. This varies with good or poor operation of the ovens from 5% to 40%. This loss is inevitable with an internally fired oven.

On the other hand, in the retort oven, there is an actual gain in the amount of coke produced over the theoretical yield of the coal in the fixed carbon and ash. This gain is caused by breaking up the hydro-carbon gases and the deposit of graphitic carbon on the surface of the coke. This gain amounts to from 5% to 15% over the ordinary practice of beehive ovens.

In proportion as the product of coke from the retort oven exceeds the product from the beehive oven, the amounts of sulphur, phosphorus and ash in the retort coke will be decreased, since these impurities start from the coal, and remain to a large extent in the coke.

We may, therefore, sum up the effect of the coke oven construction on the resulting coke as follows. The yield of coke will be increased by the greater rapidity of coking, which never exceeds 24 hours, and may often require only 16 hours, and also by turning part of the volatile into coke. Second, the quality of the coke is improved chemically, by reducing the impurities, and physically by increasing the structural strength of the coke.

Considering the Fourth Pool coals as tributary to the Pittsburg and Valley region; the coals of the Upper Monongahela and West Virginia as tributary to the blast furnaces in the Ohio Valley; the Western Maryland coals as tributary to the Eastern Pennsylvania and Maryland furnaces; and the Pocahontas coals as tributary to the Virginia and Western furnaces—the results are of fundamental importance. The improvement in the quality of the coke produced should raise the value of the coke by at least 25%, and the increase in the product of coke, which may be fairly stated from present common practice as 20% is equivalent to a profit of 20% over that obtained by present methods. For every five tons of coke produced by present practice, one additional ton will be produced by means of the retort oven, and this extra ton, requiring no extra mining or manipulation up to the time of shipping, is all profit.

Still, it must not be forgotten that no oven will make good coke out of poor coal. The fountain cannot rise higher than its source. I have no doubt that the retort oven will produce coke better than Connellsville from coals that are better than Connellsville, if such can be found. The test of 1,500 tons of Semet-Solvay coke from Connellsville coal at the Buffalo furnace demonstrated conclusively that a coke, which did not represent the best practice of the retort oven, was equal in the blast furnace, both in calorific power, in burden-bearing, and in the quality and amount of the iron produced, to the best, selected 72-hour coke that the Connellsville region was able to offer. This is the verdict of the able and impartial umpire, Mr. John Fulton, in his report to the Johnson Co., in whose interest he conducted the test. When the retort oven shall have been developed to its full possibilities on Pittsburg coals, as the beehive oven has been, a new standard coke will be the result, and the beehive may not be in it.

THE SEMET-SOLVAY RETORT OVEN.

Among the various retort ovens that are offered to American engineers and operators, the classification may be broadly made between the recuperative, horizontal flue ovens and the regenerative ovens with vertical flues.

A metallurgical engineer, considering *de novo* the operation of coking coal, would certainly not consider the heat of the regenerative furnace as requisite for the low temperature of the coke oven, which rarely exceeds 1,500° C. or 2,800 F. The addition of the regenerative furnace was an afterthought to overcome the loss of heat in penetrating the thick flue walls of firebrick. Its inventor has himself already abandoned it, and now recommends recuperation with horizontal flues. Setting aside its expensive initial cost, its liability to serious injury from careless operation, and its expensive repair charges incurred, it is from a simple engineering standpoint, a needlessly complicated construction. It seeks to accomplish by a high temperature, applied through a very limited area, that which the recuperative furnace accomplishes by a uniform and more moderate temperature through a space ten times as great. The vertical flues of the regenerative construction must do their work in a single ascent and descent through the space of six feet, representing the height of the oven, a total of 12 feet working distance. In the recuperative construction, with horizontal flues, the burning gases traverse three horizontal flues along the side of the oven, each 30 feet long, and return under the sole of the oven, making a total of 120 feet through which the heat of distillation is applied to the mass of the coking coal. The initial heat in these horizontal flues is not as intense as in the regenerative vertical flues, but as they do their work through a thin tile of only 2½ in. section, while the vertical flues are 4½ in. thick, it is easy to see that the temperature produced in the interior of the oven is much easier obtained by the recuperative construction. The solid masonry construction between and above the Semet-Solvay ovens is itself a recuperator, in addition to the heating of the incoming currents of air adjacent to the chimney flues of the Semet-Solvay oven. Together, they form a natural recuperation, of equal effectiveness with the checker work of regenerative furnaces.

It is well known that the Siemens regenerator does not produce a uniform temperature, and that this temperature varies in proportion to the periods of the reversal of the currents. For high temperatures these reversals are frequently made at fifteen minute intervals, thus overcoming as far as possible the up-and-down result to the temperature of the working furnace. When these periods are extended, as in the regenerative coke oven practice, to two hours, it is evident that at the times just preceding and just following the reversals, the resulting temperature in the oven must be subject to large variations. On the other hand, the heat conducted to the oven through the horizontal flues by the continuous method is uniform for every section of the furnace. Moreover, this uniform temperature is under very complete control, since by the admission of proper proportions of gas and air to any one of the three flues, the resulting temperature of each individual flue is under control. Any chemist will understand that the heat of fusion and distillation is most effectually applied at the lower part of the retort, and this effect is produced, as seen in the temperatures on the diagram, in the flues of the Semet-Solvay oven.

On the other hand it is equally evident that where burning gases rise through vertical flues, and are then diverted by baffling plates, the temperature is greatest at the baffling point, and it therefore necessarily follows that in the regenerative coke ovens the highest temperature is produced at the top of the flues, the reverse of the proper application of the heat to the purpose required. When through carelessness or wilfulness, the periods of reversal become extended, as every Siemen's furnace man knows from his own experience they occasionally are, the result is a melting of these baffling plates, and enormous injury to the construction. This is the fatal record of more than one retort oven construction. It is such considerations as these that prompted the remark of Mr. Darby, of the Brymbo Steel Works, Wales, that if it is possible to avoid the regenerative construction in coke ovens, enormous trouble and expense will be avoided.

Mr. Fulton states as his conclusion about the comparative working of different retort ovens, that the Semet-Solvay oven is 30% quicker in operation than any of its competitors. As evidence of this we may point to the 2,000 tons of Connellsville coal for the Buffalo test, coked in 20 hours; to 100 tons of Pocahontas coal, coked in 16 to 18 hour; to 100 tons of Fourth Pool coal, in a recent experiment coked in 20 to 22 hours. From these results we can confidently assert that the Semet-Solvay oven will produce 2,000 tons of coke from Pocahontas coal in one year, or 1,600 tons of Connellsville or Fourth Pool coke. No oven in Europe or America has reported results within 30% of this record.

This rapid operation of the Semet-Solvay oven affects both the original and the operating cost. It will require twice as many ovens making 36 or 48 hour coke as Semet-Solvay ovens making 18 to 24 hour coke. The operating expenses in the Semet-Solvay ovens will also be greatly reduced. These are vital elements in American constructions. The Connellsville coal from the Valley mine sent to Europe in 1893 required 38 hours for coking in the regenerative oven with vertical flues. The coal from the same mine at Syracuse required only 20 hours.

When the direct object of the retort oven is for the production of fuel gas as well as coke, this rapid operation becomes of greatly increased importance. The distillation of the volatile is not even through periods of the time of exposure in the oven, but proceeds with great rapidity during the first half of the time, and very slowly towards the close of the coking operation. It is, therefore, possible, by shortening the coking period, to coke two charges in 24 hours, and produce nearly double the amount of gas and coke, which, for many purposes, will command as high a price as blast furnace coke. In the Semet-Solvay oven, this operation is practicable without any change in construction, but by a simple difference in operation.

In conclusion, we may consider it as fairly demonstrable that, whether for coke or gas, the Semet-Solvay oven is constructed upon correct principles; that it is, both in construction and operation, more economical and rapid than any of its competitors, and that it is available as a working device to the coal miners and blast furnace operators of the Pittsburg and Ohio fields as a profitable investment.

Mechanical Rubber Goods and Hose.

It is reported that the New Jersey Car Spring and Rubber Co., of Jersey City, N. J., and the Eureka Fire Hose Co. of New York, two of the largest and oldest manufacturers of hose in the country, and whose business relations have for the past twenty years been very close, recently completed arrangements whereby the two companies will be still closer connected in the manufacture of fire, mill and other kinds of hose.

All the brands of both concerns will hereafter be made and sold by each company. The line will be a most complete and extensive one, embracing as it does hose for every purpose, each brand of acknowledged superiority in its class. This arrangement, we take it, will not alone prove desirable for the New Jersey Car Spring and Rubber Co. and the Eureka Fire Hose Co., but will be a great convenience to the patrons of both concerns.

EASY LESSONS ON MINING.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Geology of Coal," "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING MACHINERY.

The Knock in Pump Valves—The Halt of the Cornish Engine—The Double Beat Valve—The Cornish Valve—The Piston Balance Valve—Recapitulation of Facts.

117. **The Knock in Pump Valves.**—To secure more than the average efficiency in the working of mine pumps, valves of the best construction and mode of action must be used, and as this is so, pump valves have been made the subject for study in this lesson.

To make the investigation progressive, however, we will begin with the primitive example, and this is illustrated by Fig. 151. The word valve means a folding door, and the valves of a pump are said to be self acting, because at the moment of opening or closing, the pressures at opposite sides of the door are different, as for example, when the valve lifts, the pressure under it is greater than the pressure above it; and at the moment of closing, if the piston of the pump is stationary, then the valve falls by its own weight, or on the other hand, if the engine begins its reverse stroke before the delivery valve has had time to fall, then the velocity of fall is accelerated with a weight on it equal to that of the delivery head, and it is in the latter case that the heavy strain on the delivery valve, called knock occurs.

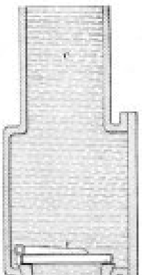


Fig. 151.

There are still some rod pumps and Cornish engines at work in mine drainage, and on that account, and also to explain the knock, we introduce this valve for our first consideration.

With the rod pumps and the old Cornish engine there was no real knock, because the engine halted for three or four seconds at both ends of the stroke. At the top of the stroke, the halt allowed time for the suction valve to fall, and at the bottom of the stroke, the halt allowed time for the delivery valve to fall, so that in this case the only knock that could occur, was due to *only a portion* of the weight of the valve, because the valve was moving in water. The comparatively light construction of the valve seat was such that it could not withstand a knock of relatively small amount and this fact can be at once realized by reference to the figure, where the delivery valve is seen at *V*, and *C* is the vertical column of water resting on it. We see then, that this valve could only be employed in cases where a halt was made at each end of the stroke, and therefore, in pumps worked by a rotary engine that does not make the required halt, if some provision is not made to avert the knock, it is sure to occur, and its severity is proportionate to the piston speed of the pump and to the height of the delivery column; for at the moment of suction, a slight fall of the water column resting on the valve occurs, and should the pump be running at a relatively high speed, and the height of the delivery column be considerable, it does not require much mechanical intuition on the part of the student to discover that ordinary fall valves, like that in the figure, or butterfly valves, that is, those with two doors opening in opposite sides of a middle hinge set over the waterway, or common button valves, that is, round valves working on a guide spindle, will fall onto their seats with such destructive force that they soon become inoperative.

118. **The Halt of the Cornish Engine.** The object, then, of the halt at the ends of the strokes of a Cornish pumping engine is to prevent the knock of the valves, and we can therefore see that for the continuous action of a rotary pumping engine some provision must be made to prevent the occurrence of an excess of pressure on the upper sides of the valves, and we may be sure that like all other modes of action in mechanics the prevention of the knock has been accomplished by various devices in the construction of the valves. There are so many different makes of this class of valves in use that we can only treat with profit on the three fundamental ones that embody the principles of construction and modes of action of all the others.

119. **The Double Beat Valve.** Fig. 152 is an illustration of a double beat valve, sometimes called an equilibrium valve. The valve in the figure is not, however, a true equilibrium valve, because the top valve *V* is larger in diameter than the bottom valve *v*, but it belongs to that class of valves. The difference between *V* and *v* is much greater in the figure than in a real case, but in the diagram the exaggeration is necessary to give clearness to the principle involved. To understand the "equilibrium," or "double beat" valve in the figure, let it be granted that the area of the under side of the top valve *V* is equal to the area of the top side of the bottom valve *v*, and that these two valves fit close on their seats. Now, under the conditions granted, the ingoing water *I* will exert the same pressure under the top valve *V* as it exerts on the bottom valve *v*; consequently, we have here an upward force exactly equal to a downward one, and the result is the double valve will not rise until the upward force is made to exceed the downward one by an amount equal to the weight of the valve. It so happens, however, that the valves never fit their seats with such perfect accuracy as to make the bottom side of the top valve exactly balance the top side of the bottom valve, and therefore the excess of lifting force is easily provided for in the case of water valves.

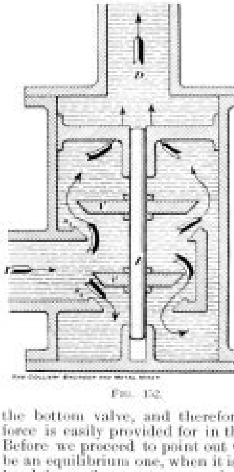


Fig. 152.

Before we proceed to point out where this valve fails to be an equilibrium one, when it is set under a great water head, let us first try to comprehend its principles of construction. By the figure, we can see that one chamber is set within another, and that the inner chamber *I* only communicates with the outer one by the valve ports s_1 and s_2, and therefore, when the valves *V* and *v* are down on their seats, the communication between the inner and outer valve chambers is entirely cut off. In the figure, the valves are up off their seats, and it will be further seen that both valves are fast to one spindle, and therefore they both rise and fall together. The course of the entering water *I* is indicated by the arrows as passing up through the top valve port and down through the bottom valve port into the outer chamber, from which the flow from both valve ports passes into the delivery pipe at *D*. This valve has done good work as a steam valve, and in that case its movements were controlled by the engineer or the cams of the engine, and it can, indeed, be used as a perfect equilibrium valve at the moment of the lift, but at the moment of the fall it is entirely out of balance, as the result of having two seats, and it is therefore subject to a serious amount of knocking force. Let us suppose it is used as a delivery valve; then at the moment the plunger takes the suck a depression occurs at *I*, and then the weight of the column *D* gives a greater downward force on the top than on the bottom valve, because their top areas are unequal, and as this inequality cannot be taken off, the equilibrium valve cannot be taken as a shockless valve for a pump. We next have to consider the claims of the Cornish double beat valve as an equilibrium valve for pumps, and this is illustrated by Fig. 153.

120. **The Cornish Valve.** This valve is the same in principle as the double beat valve we have been noticing, but it is different in construction, and it is to explain this divergence that we introduce it. The valve consists of a case, *C C*, that may be likened to a pot inverted with a hole in the top end; the edges of this hole are the counter seat of the top valve, and rest on the mitre seat of the valve that is fast, and therefore, does not move on the supporting spindle, *S*. The wide end of the case, or pot, has its edge mitred, and therefore the top seat of the valve is shown as s_1 s_1 and the bottom seat at s_2 s_2. This case valve then, is a truly double beat one, and the case is at once the two valves, and the analogue of the inner chamber of the equilibrium valve with a double seat. For steam it is an equilibrium at the moment of opening, but for water it has the same defect as the former one, namely, a heavy knock at the moment of closing. Many modifications of these valves have been tried for pumps, but none of them have given the required result, namely, a valve that is nearly in equilibrium at closing. The valves in common use have a small lift and the knock is prevented by a counteracting spring that can have its cushioning power increased or diminished at the will of the engineer in charge, but the defect in this case arises more from mistaken management, than from any fault in the mode of action.

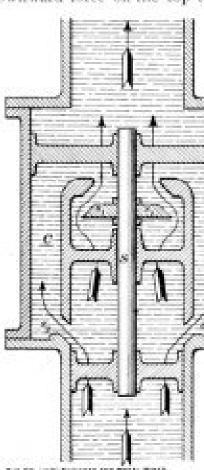


Fig. 153.

121. **The Piston Balance Valve.**—Fig. 154 is a true equilibrium valve, and can be made to balance both at opening and closing as it has only one valve seat and therefore the knock can be reduced to a minimum without the use of a percussion prevention spring. The construction and mode of action is as follows: The valve *V*, is fastened to the same spindle as a piston *P*, and the area of the piston is made sufficiently less than the area of the underside of the valve to provide for lifting pressure. In the figure the seat of the valve is mitred, but in practice the mitre does not answer for a valve of this kind, for a *narrow* flat seat renders it possible to reduce the difference of the areas of the piston and the under side of the valve to a minimum and thereby prevent the possibility of knock. The mode of the balance in this case is very interesting, and it will now be explained. *C* is the delivery column and its weight presses the under side of the piston *c* and the upper side of the valve *d*; *D* is situated between the suction valve and the delivery valve *V*; the equilibrium pipe *E* connects the water space above the piston at *b* with the water space between the suction and delivery valves at *a*. During the suction stroke the pressure under the valve at *a* and above the piston at *b* is considerably less than the pressure of the atmosphere, and the result is the pressure under the piston and above the valve is at that time equal to that due to the head of the delivery column, but the pressure on the valve being a little greater than that under the piston, the valve falls at this period gently into its seat. During the forcing stroke the pressures above the piston, and beneath it, and above the valve, and beneath it, are all equal, and therefore the valve opens gently. The secret, then, of this valve's action is this, the pressure per square inch of the water above the piston, and beneath the valve, are always *equal*, and the pressure per square inch of the water beneath the piston, and above the valve, are always equal, and the result is this valve is always balanced in opening off and closing on one seat. The guide for the valve and piston spindle is left out, to prevent the obscurity it would introduce into the diagram. Such then is a summary of the devices that have been tried and practiced to prevent the knock of pump valves.

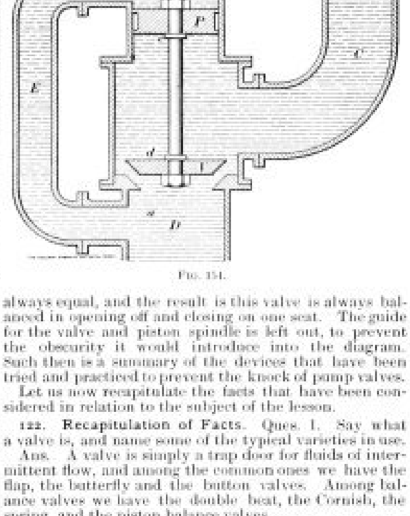


Fig. 154.

Let us now recapitulate the facts that have been considered in relation to the subject of the lesson.

122. **Recapitulation of Facts.** Ques. 1. Say what a valve is, and name some of the typical varieties in use.

Ans. A valve is simply a trap door for fluids of intermittent flow, and among the common ones we have the flap, the butterfly and the button valves. Among balance valves we have the double beat, the Cornish, the spring, and the piston balance valves.

Ques. 2. How was the knock on the valves of the rod pumps, worked by Cornish pumping engines, prevented?

Ans. The pump piston was made to halt at each end of its stroke, to allow time for the valves to fall with their own weight, and the duration of the halt was controlled by the cataract, which is a small cylinder and piston that fills with air like a bellows during the upstroke, and the period of discharge is regulated with an adjustable valve.

Ques. 3. How does it occur that the latest makes of pumps for mine drainage, do not contain the flap, or butterfly valves of the Cornish pumps?

Ans. The latest makes of pumps are continuous in their action, and therefore, the valves are closed before they have time to fall in water, and the result is, a slight fall of the column occurs at the period when the valve closes and this produces a severe blow, called "the knock," and therefore the old class of valves are unfit for this hard usage.

Ques. 4. How does it happen that the equilibrium, or double beat valve, does not prevent the knock when used as a pump valve?

Ans. The equilibrium or double beat valve is only a balance at the moment of opening, but on closing it is so much out of balance that it is subject to a severe knock and this is the result of two valves falling on *two seats.*

Ques. 5. In what respects are the equilibrium and Cornish double beat valve alike?

Ans. The Cornish valve is in all respects a double valve, and consequently has two seats, that make the difference of the areas so great that, on closing, a severe knock is produced.

Ques. 6. What is the special advantage of the piston balance for a valve that has to support a high head of discharge?

Ans. The special advantage of the piston balance is, the valve only falls on one seat, and therefore by making the valve seat narrow and flat, the valve falls with very little knock.

Ques. 7. How does the piston balance the valve?

Ans. The pressure of the delivery column under the piston and above the valve is equal, and by the connection made with the equilibrium pipe the pressure between the suction and delivery valves is always the same as that above the piston and under the valve, and as the valve and piston areas are nearly equal, the piston balances the pressures on and under the valve.

(To be continued.)

CHEMISTRY OF MINING.

Facts Relating to Safety Lamps—The Glass Shell for a Light—The Claims of a Small Flame—The Diffusion of the Lights of Lamps—The Heating of Lamp Glasses Should be Prevented—General Recapitulation.

105. **Facts Relating to Safety Lamps.**—As this lesson will conclude the series on "lamp glasses," we are anxious to eliminate from our decision all errors of misconception; but even after we have done our best, let it be remembered that there is no finality in investigations of this kind, and therefore, we only claim to have initiated an inquiry that will, we hope, bear good fruit in the construction of lamps that will give a better light than those in general use.

The summation of the facts will proceed in such a way as will best support the conclusion we have arrived

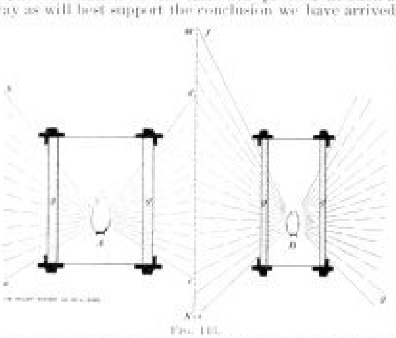


Fig. 143.

at, namely, that a good small light in a glass cylinder of relatively small radius, will give a better light, and secure a safer lamp, than a large dull light within a glass shell of relatively large radius.

106. **The Glass Shell for a Light.**—The importance of a glass shell to incase a light, is not a question for the miner only, but one that affects all classes alike, for with the exception of the candle, all artificial lights are set within the screen of a glass shell. And why? Simply to reduce the painful dazzle or glare of the light near the eye, for the flame consists of a stream of white-hot gases convolving in little cyclones, and as the rays from the light are constantly having their diverging courses deflected, the result is, the dancing rays fatigue the eye and weary the mind. The dazzle is the same in character as the twinkling of the stars; and the chief cause of injury to the eye in looking at the sun arises from the same cause intensified, for the heat rays of the sun cause convolving movements in the air while passing through it. Who can recount the patents that have been secured for the protection of glass shades for gas lights? and yet we have not seen one yet that is satis-

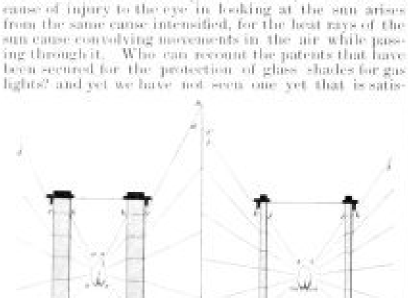


Fig. 144.

factory in use, for all of them waste 60 or more per cent. of the light, and yet people are willing to suffer the loss of light so that they may be spared the pain produced by the dazzle of a naked flame.

107. **The Claims of a Small Flame.**—A small flame does not always mean a low intensity of the light, for in the case of a safety lamp the illuminating power of the light ought rather to be increased than reduced, but if we can get a better light with a small flame of high intensity, than with a large flame of low intensity, then the small flame is the best. Again, if a better and safer lamp can be made for a small flame, than a large one, by all means find how to make the small flame give sufficient light. Perhaps the following furnishes a decisive claim for the small flame; the volume of the light diffused is greater from a glass cylinder of small diameter, than from one of large diameter, as demonstrated by Fig. 143, where the volume of the diffused

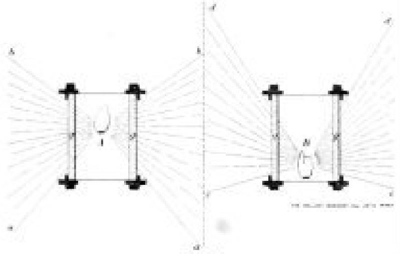


Fig. 145.

light from the narrow glass *B*, has a depth equal to *f c*, and that from the wide glass *A*, has a depth equal to *d c*. It has already been shown that the lighting of the floor and the roof as well as the sides, is an important requirement for the miner's safety, and that to obtain this by the refraction of the light from a thick glass is a mistake, as it seriously hinders the passage of the light, and even a cursory glance at Fig. 144, suggests this fact, but a thick glass does more than that, it increases the size of the lamp frame without furnishing any compensating advantage.

108. **The Diffusion of the Lights of Lamps.** We see, then, that the question before us is not only one of diffusion, but also of economy; and, therefore, diffusion as good as that shown by the depth of the bundle of rays at *A B* should be obtained with a glass whose inside diameter is no less than that of the figure, yet much thinner in the shell. With a flame proportionately reduced, however, a glass still smaller in diameter could be used, and then the depth, or volume of the light would be increased, or the vertical range of diffusion would be increased. It may occur to the reader that the reduction of the light will be attended with some difficulty, but this will form the subject of inquiry in the succeeding lessons.

The length of the glass for a safety lamp is a matter of first importance, because however small we may make the diameter, unless the length is proportionately increased, no advantage can occur, for if we inspect that portion of Fig. 143 marked *B*, we can see that any reduction in the length would reduce the vertical ranges of diffusion, and this being so, it is clear that a proportion of the length to the diameter should be fixed on, and and here we may say that the length of a lamp glass should never be less than twice the diameter, but as we propose that the flame shall be small, and yet give a light of high intensity, and, further, as we will ultimately propose that the length of the gauze cylinder should be shortened, we may say that the best length of the glass shell, to secure good diffusion and an ample motive column for the ingress of air, should be 2½ times the diameter.

109. **The Heating of Lamp Glasses Should be Prevented.** The heating of the glass ought not to occur for three reasons. The first is, a hot glass is very liable to be cracked in the event of a drop of water falling on it from the roof; the second is, hot glass

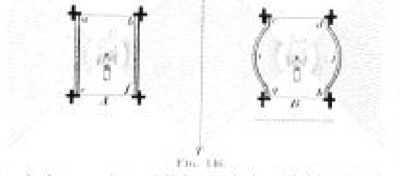


Fig. 146.

is a bad transmitter of light; and the third is, glass is a bad conductor of heat. The three properties of glass just noticed appear at first sight to favor the conclusion that a large glass could be kept cooler than a small one, but in the event of the air entering the lamp being an explosive mixture, then the sheet of flame within the glass would raise its temperature to the point of danger, and thus jeopardize the security that the lamp should provide. When gas and air are burning within a lamp the combustion of the oil at the wick is retarded, or, in other words, the normal flame is reduced, but still it continues to burn for a period that is more or less prolonged, according to the conditions that prevail, but if the entering air is dangerously charged with gas, and the lamp is a good one, the flame at the wick ultimately expires, but the period of the duration of the wick flame is longer in a lamp of large than in one of small capacity, and therefore the lamp with a glass of small diameter is again the best.

Now, the conclusion of the whole matter is this: A lamp glass ought not to be more than 1.75 inches in inside diameter, and our ideal ought to be 1.5 inches, then with a length of 2.5 times the diameter, the length of the glass should not be less than 3.75 inches.

Next let us recount the facts of the investigation by a series of questions and answers.

110. **General Recapitulation.**—Ques. 1. At what height should a flame be set on the wick within the glass of a safety lamp?

Ans. The center of the flame should occur at an elevation of one-third the height of the uncovered portion of the glass cylinder, for otherwise the light would be unevenly distributed on the roof and floor, as illustrated by Fig. 145, where at *A* the light is set too high and at *B* it is set too low.

Ques. 2. What advantages can be secured with a lamp glass of small diameter?

Ans. When the length of a lamp glass is the same for one with a small, as for one with a large diameter, then the one with a small diameter has the greatest range of vertical diffusion, and therefore provides greater safety for the miner.

Ques. 3. What are the advantages and disadvantages of a thick glass shell for a safety lamp?

Ans. There is only one advantage that can be claimed for a thick glass, and that arises from refraction, for this secures a greater range of vertical diffusion. The disadvantages are: First, loss of light by interference; second, a thick glass requires a wider frame; and third, the danger the glass is liable to of cracking in an explosive mixture.

Ques. 4. When the diameters of the ends of a spherical, or bulging glass, are the same as those of a cylindrical one, does the former give any greater range of vertical diffusion than the cylinder?

Ans. By Fig. 146 it is seen that the spherical glass does not increase the vertical range of diffusion, for the

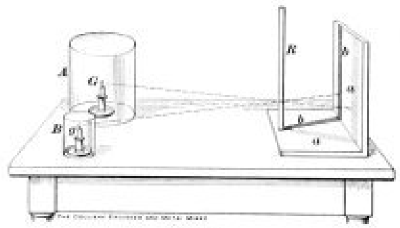


Fig. 147.

range of the cylinder *A* is equal to that of the bulging glass *B*.

Ques. 5. Does the surface area and thickness of a glass shell over a light affect the illuminating power?

Ans. We have already seen that a thick glass offers a greater resistance to the passage of light than a thin one, and, therefore, if we take the thickness in two cases to be equal, as in Fig. 147, the glass with the smallest surface area intercepts the least light, for as the resistances vary directly as the areas of the intercepting mediums, when the thicknesses are equal, then the shell *A* inter-

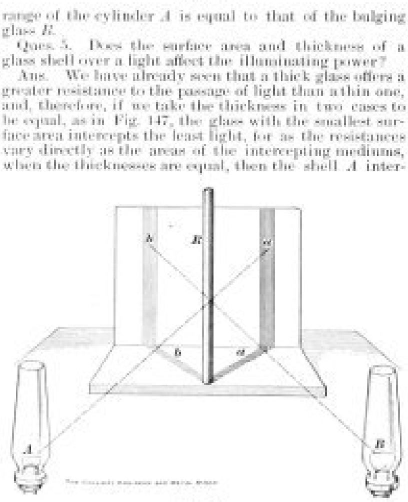


Fig. 148.

cepts more light than the shell *B*, in the proportions of their diameters. Again, it is further shown by the figure, that a strong light makes a deep shadow, while a feeble light makes a faint one.

Ques. 6. Why is a large flame objectionable in a safety lamp?

Ans. When the flame is proportionately large, the glass becomes overheated, and then offers a greater resistance to the passage of light, as in the case of the two kerosene lamps in Fig. 148. For after the large flame in *B* has increased the temperature of the glass chimney, the intensity of the light transmitted is

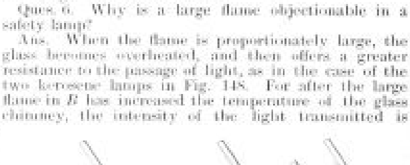


Fig. 149.

reduced, and then the smaller light seen in *A* is found to give the best light as shown by the photometer.

Ques. 7. What is the relationship of the length of the flame of a lamp to the radius of the glass cylinder?

Ans. This relationship is clearly shown by Fig. 149; for if the radius of the glass cylinder does not exceed the length of the flame, then the glass will be blackened and broken in the event of the lamp falling on its side.

Ques. 8. What should be the maximum diameter and the minimum length of the glass in a safety lamp?

Ans. The maximum diameter of the glass cylinder in a safety lamp should not exceed 1.75 inches, and the minimum length should not be less than 2.5 times the length of the diameter.

(To be continued.)

GEOLOGY OF COAL.

The Great Land Masses—The Areas of Land and Water Never Vary—The Axes of the Rock Waves. The Effects of Erosion—Hot Water Discharges. Recapitulation of Facts.

63. **The Great Land Masses.**—We cannot look at a map of the world through geological spectacles without observing that the present continents appear to be only the remains of a once greater land mass, that has been so much eroded that the present ones are only the fragments of the greater whole that once covered large portions of the present sites of the Atlantic, Pacific and Indian oceans.

It is not, however, likely that the area of the dry land surface of the globe was ever greater than it is now, for if we try to believe otherwise we find that to do so we must accept certain conclusions that cannot be sustained by evidence; as for example we would have to believe that the dry land was situated at greater elevations above the sea floor than now, for the volume of water on the earth would not be less, and if it was confined within more restricted lateral limits, the seas would have to be much deeper to contain it.

64. **The Areas of Land and Water Never Vary.**—After looking at the facts just related, we might say again, the contour or outlines of the present land masses is such that we cannot but conclude, notwithstanding the difficulty of the requisite elevation of the land or the increased depth of the sea, that somehow or other the continents belong to a former great whole; for if we associate Greenland with North America, it does seem to be a piece that has been just cracked off, and therefore if we join this piece to North America, Europe, Asia and Africa appear to be a large mass broken off from Greenland and the continents of North and South America, and that the present site of the Atlantic ocean lies in the great fissure.

Looking at the map again we can see traces of the outlines that have not been worn away by the great erosion that has taken place between Greenland and Europe, and some of them are Iceland with many other smaller islands, and some greater ones, as the British Isles.

The contour of the western coast of Norway fits that of the eastern coast of Greenland: The southern shores of the Gulf of Guinea fit the northern shores of the South American continent, and the promontory of the Sahara and the Soudan of Africa fit into the continental recess at the mouth of the Gulf of Mexico. That these contour lines are not the result of an accidental coincidence, but of the operation of laws that produced the rupture, cannot be doubted, for the lines of the former bond are still to be found in the North Atlantic, where between the Bay of Biscay on the European side, and Newfoundland on the North American side, we find unbroken lines of small islands and shallow waters, and dangerous rocks scarcely covered with water. Off the promontory of the Soudan in Africa, we have the Cape Verde Islands on precisely the same latitudes as that vast group of islands in the great recess on the eastern side of the two great continents of North and South America; that is, that vast group of islands near the entrance to the Gulf of Mexico, of which St. Domingo and Cuba are the largest. Now by placing these facts in order, no doubt whatever can exist of the former continuity of the continents of North and South America, the large land mass of Greenland, and the continents of Europe, Asia and Africa.

Coming to the western side of the continents of North and South America, we find the nose of Prince of Wales Cape at the extreme western limit of Alaska, nearly touching the extreme eastern limit of Asia at East Cape in Russia, and still more remarkable is an immense curved line of islands, reaching from the Alaska Peninsula in North America, to the Peninsula of Kamchatka in Russia in Asia. Perhaps the most singular bond has yet to be noticed, and it is this: From Japan on the north to New Zealand on the south side of the equator, an immense belt of *thousands* of islands extends from the eastern sides of Asia and Australia nearly to the western sides of the continents of North and South America, and if a general contour line is made to enclose this vast group of islands and join them to Asia and Australia, then we discover that all the great land masses have at some period in the past been parts of a great land whole that has been divided by some agencies we are now seeking to discover.

We have, however, established a conclusion that cannot be undone, and that is that the volume of water on the earth could not be confined within narrower limits than the present ones, and if this is so, we ask what mean these lines that indicate the former bonds of the land masses, for if we unite the continents by land that displaces the Atlantic, Pacific and Indian oceans, where would the waters of these seas that are the chief reservoirs of the whole earth find a lodgment? To this enquiry no reply can be given, unless we discover that erosion is not the only cause of the peculiar contours of the land masses.

65. **The Axes of the Rock Waves.**—To find the cause of the bond lines, let us look at the map again and observe that the general direction of the axes of the mountain systems of the land masses is north and south, and from this cause the great capes are all pointing southward. The general direction of the axes of the great mountain systems indicates that great rock waves are moving round the globe either from east to west or from west to east, and their advance is slow and majestic, but sure. The cause of these great waves is a common one, and is, no doubt, the result of the cooling and shrinking of the earth, for this shrinkage would cause an acceleration of the earth's rotation, or the higher linear velocity of a wide zone in the earth's shell will tend to give this mass a greater angular velocity than that of the interior kernel, with the result that this belt will buckle and advance eastward, making the direction of the motion of the rock waves from west to east.

The rock matter composing the dry land will then simply have a vertical motion, instead of one of translation, and, therefore, between the crests and the troughs of the rock waves the bond lines will occur just as we find them, and the contours of the continents will therefore arise chiefly from the parallelism of the axes of adjacent rock waves. That this conclusion is correct, is capable of proof, because the giant march of these waves is proven by the work they have done in building up the stratified rocks, for in no other way could these rocks ever have existed. The conditions required for the formation of stratified rocks are: First, elevated land, subject to erosion from various agencies, a condition supplied by the crests of the rock waves. Second, depressions in which the sediment of erosion can collect and be arranged by lamination, as in the troughs of the rock waves. We now see that the very existence of the stratified rocks is due to the constant march of the rock waves, by which the floor of the sea has been repeatedly upraised and depressed; and a further consideration of the subject still more establishes the conclusion, for if we examine a section of coal measure strata, we find that every stratum in the series tells the story of its own special submergence, and the coal seams the series enclose are the indices of the periods of emergence, or the times between which the intervening strata were deposited.

66. **The Effects of Erosion.** The stratified rocks, then, are the result of a a dual cause that may be studied under the heads of erosion and crust motion. The crust

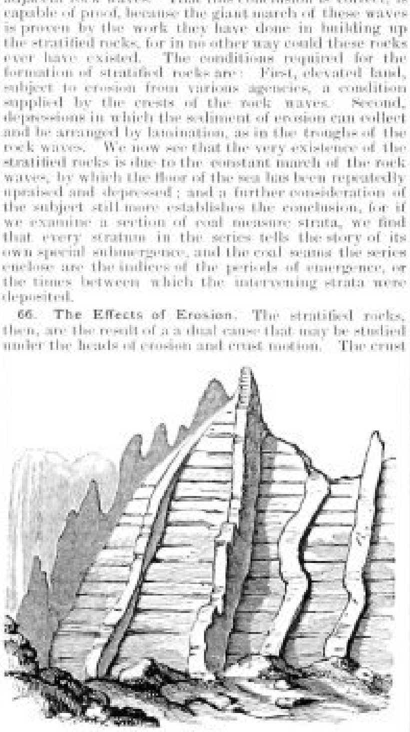


Fig. 100

motion we have just considered, and now, therefore, let us briefly notice some of the effects of erosion. Fig. 100 interests us as a very sharply defined example of the effects of erosion. Here the scoria of a volcanic mountain has been cracked, and then had the fissures filled with molten lava, and after the lapse of long ages the scoria has been eroded, and the contents of the lava dykes that have not been disintegrated by the agencies of waste are made to stand out in bold relief like the plates or walls of solid trap shown in the figure. These protruding dykes, then, manifest in a very marked manner the general fact that everywhere confronts us in geological investigations, and it is this: The different classes of rocks are differently affected by the forces of erosion,

Fig. 101.

and, therefore, by a still greater generalization, we see that all the various coast lines of the great land masses are rugged and indented in the proportion of their power to resist the agencies of waste.

67. **Hot Water Discharges.**—In coal mining we deal with the consideration of rocks that are organically derived, for such are the coal seams, but in metal mining we have to deal with rocks that are chemically derived, as the minerals and ores in the lodes, and to emphasize the cause of the deposition of many of the metallic ores, namely their solubility in hot water, we introduce Fig. 101. Now, the presence of quartz indicates a deposition from *very* hot water, and so much is this the case that when the solvent fluid begins to cool the dissolved silica at once begins to crystalize out in a gelatinous condition, and on further cooling it solidifies, and this is exemplified in the rough cone-like mass of silica that surrounds the mouth of the "Giant Geyser" before us. Let us in conclusion say to our readers, if you wish to master the principles of geology, or that branch of science that treats on the characteristics of the rocks in the earth's crust, do not be content with the deductions that are circumscribed by local considerations, but search for the laws of operation that comprehend the whole of the facts.

68. **The Recapitulation of Facts.**—QUES. 1. What thought strikes you on looking at a map of the world?

ANS. The thought that strikes me is that the land masses of the continents are but fragments of a once greater mass that included them, and covered the present sites of the Atlantic, Pacific and Indian oceans.

QUES. 2. Has the proportionate area of the dry land ever been greater than now?

ANS. The proportionate area of the dry land has never been greater than now, and on the other hand, the proportionate area covered by water has never been less than now, for if the land area was increased, and the water area reduced, the elevation of the increased area of dry land would have to be very much increased to make a proportionate depression for a depth of the sea, far exceeding what could take place without the water pouring into the heated kernel of the earth.

QUES. 3. What is the direction of the axes of the great rock waves?

ANS. Looking at the map of the world we see that the axes of the *great* mountain systems, and the land masses, are all nearly north and south, and therefore the axes of the rock waves are the same.

QUES. 4. What is the probable cause of the north and south direction of the axes of the rock waves?

ANS. The probable cause of the north and south direction of the axes of the rock waves is the shrinking of the earth, and the consequent shortening of its diameter, by which a portion of its linear velocity is converted into angular, and thus the shell of the earth between the latitudes 70° north and 70° south is subject to a relative advancing strain that produces the rock waves. The advance of a rock wave then causes the sea floor to be upraised on one of its sides and depressed on the other, and the cause of the direction of the axes of these waves is to be found in the fact, that the axes of all waves make a right angle with the direction of the force that produces them.

QUES. 5.—What two modes of action have produced the stratified rocks?

ANS.—The two modes of geological action that have produced the stratified rocks are first, erosion, resulting from the action of the agencies of disintegration; and, second, the rock wave action by which the sea floor is alternately raised and depressed.

QUES. 6.—In what way has hot water been an active agent in the deposition of metallic ores?

ANS.—Many compounds of the metals are soluble in hot water, and only partially so in cold water, and, therefore, where the compounds of the metals that are soluble were present in the rocks that were traversed by hot water, these metallic compounds were dissolved out and deposited by crystallization in veins or adjacent fissures.

MINING METHODS.

Dust Raised by the Wind—How the Clouds are Suspended—The Classification of Mine Dust. Recapitulation of Facts.

Erratum. In the recapitulation of our last lesson, page 236, question 6, an error occurs in the index of the root taken, and, therefore, the correct answer should be as follows:

ANS.—Yes, there is such a relationship when the cubes or spheres are of the same material, and that is, the limiting velocities are directly as the *sixth* roots of the weights or contents. For example, the limiting velocity of a cubic inch of coal is 75.24 feet per second, and in this case take a little cube of coal to have a content equal to the $\frac{1}{181,423,106,666}$ of a cubic inch; then the limiting velocity will be $\sqrt[6]{\frac{1}{181,423,106,666}} \times 75.24 = 1$; that is, the limiting velocity of this particle of dust is 1 foot per second.

100. **Dust Raised by the Wind.** Even the dust raised from the roads by the wind becomes a subject of engrossing interest when the laws that control its suspension are understood, and perhaps in the case of the miner this is especially so, for the only difference between the dust lifted by the wind from the roads and that lifted by the air currents of the mine is that of their specific gravities; and this being so, the dust lifted by the wind receives in this lesson first attention. Fig. 138 is an illustration of a dust cloud, and let us first notice that the velocity of the wind near the ground is lower than at higher elevations, and this is the result of the resistance due to the roughness of the ground, or the inequalities of its surface; hence, at *c* the velocity is proportionate to the length of the shortest arrow, and at *b* and *a* the velocity is shown to increase in the proportion of the lengths of the longer arrows. On closely watching a dust cloud, the highest stratum, as that above the line *D*, is seen to consist of the finest *visible* particles,

and that portion of the cloud above C is seen to consist of larger ones, and looking lower at the convolving dust and above the levels B and A, the particles appear much larger than those above, and if we watch the surface swept by the breeze, we will find that pieces of paper, sticks and straws are swept along as with a brush, but never rising to a high elevation unless the speed of the wind is at a dangerous velocity, and then portions of the roofs of houses and other erections may be carried off.

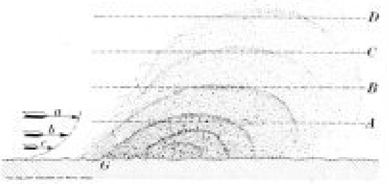


FIG. 138.

The dust cloud in the figure is shaded to sharply define the elevations of about six grades of dust, but the particles are so various in size that they could not be classified by a scale of millions. Again, it would appear as if all the fine particles were above the line D, but that is not correct, because before they reached the higher elevation they rose from a lower one. There are, however, particles under D that cannot rise above it, and there are other particles that cannot rise above C or B or A. The cause of the limited elevations that characterize the particles of different sizes is found in the varying velocity of the wind, for it does not move with a constant and uniform velocity, but blows in gusts, and therefore the grosser particles are lifted by the highest velocity of the gust, and never reach a high elevation before they begin to fall, while the small particles, with a relatively large surface area of suspension, move upward and onward to greater elevations.

101. How the Clouds are Suspended.—The clouds consist of little water spheres that are so small that if a rain drop was set beside them, it would look like a relatively large ball, and yet the particles of water dust that make the different clouds are of different sizes, and as we may expect, the smallest particles are found in the clouds that float the highest; for example, the cirrus or white feathery clouds that soar above the flight of the eagle, are composed of smaller particles than those that go to make the cumulus or mountain clouds that float at a medium elevation. The cumulus clouds are often taken as the precursor of rain, but the nimbus is the true rain cloud, and it is either produced by the opposition of winds that cross each other's path, and in doing so make the particles of the cumulus clouds collide with each other and coalesce as rain drops, or the cumulus clouds strike the sides of mountains, when the particles coalesce and form nimbus clouds. We see then that all kinds of dust consist of small particles of matter whose surfaces of suspension are so relatively large that they are easily lifted by the air. Fig. 139

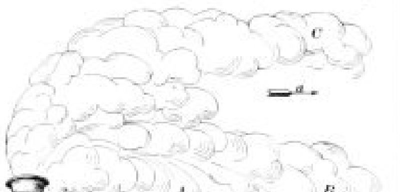


FIG. 139.

fully sustains the conclusions arrived at in relation to dust particles, for here we have illustrated the behavior of the particles in a cloud of water dust, that has been produced by the condensation of steam. The water dust in steam must consist of particles of *very* different sizes, because the water of condensation in the cylinders will be ejected as spray, the condensation of the steam as it passes through the valves and steam ways will generate particles of many sizes, and further, the varying velocities of the steam when exhausting, will affect the sizes of the particles produced. Now, as the result of the exhausted particles being so different in size, when the steam is blown out of the funnel of a steam engine, such as a locomotive, the cloud is seen to bifurcate, and trifurcate, just as the illustration indicates; for the heavy particles form a bottom prong, as at A, while the intermediate ones form the middle prong B, and the lightest particles form the top prong, as at C. We see then that the different sizes of the particles become associated as cloud tails, as at A, B and C. A cloud of smoke from a chimney where bituminous coal is burnt, furnishes the same phenomena, and to look at such a cloud when you know the facts, makes them not soon forgotten.

102. The Classification of Mine Dust. Fig. 140 brings us to the practical application of our subject, and we need not now waste time by doing more than explain the diagram, and then proceed to show the value of the facts here set before us. The little circles containing the arrows, are graphic illustrations of the velocities in different air passages in a mine, as for example, the velocity v, in the top drift, is only able to suspend *very* fine dust, while along the floor of this passage a larger gauge of dust is seen to be deposited, and this dust is easily lifted, because the current is just a little too slow to suspend it, and therefore, the movements of the feet of men and horses, and the shake produced by trains of cars, cause it to rise in clouds; the floor dust in this case is marked d_2.

The current in the middle drift holds in suspension d_1 and d_2, and the dust for which this current is a little too slow is d_3, and this lies on the floor, and in the current velocity that prevails it is easily lifted by the tread of men and horses and the running of the cars.

The current in the bottom passage holds in suspension dusts d_3, d_2 and d_1 and as this current is just a little too slow to suspend d_4, it lies on the floor, and it too is easily raised by the tread of men and the movements of the cars, and so we see that each class of dust is raised by a particular velocity of the air current.

The object of these lessons on coal dust is of a threefold character. First, to discover what *dust* is; second, to determine the nature of the conditions under which it becomes suspendable in air; and third, to find a method of classification by which different sizes of dust particles can be associated with air currents moving at different velocities. The first two points have been determined, and the third one now only requires for its complete development a finishing touch, and after the conclusion of much labor and thought we recommend the following mode of classification, for it is at once simple and correct: We now know that the sizes of the largest particles in suspension in a current are the limit-

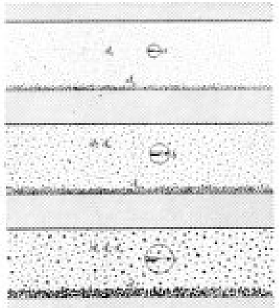


FIG. 140.

ing ones for that velocity, and on the basis of this fact we now propose to establish a classification by the velocity of the current in feet per second in which different sized dusts are suspended, as $10v$, $11v$, $12v$, for dusts carried in suspension at velocities of 10, 11, 12, etc., feet per second. Dust has been classed as flocculent dust from colliery A, or B, or C; but the dust from colliery A might, in a test, be more explosive than that from colliery B; but had the dust from colliery B been dropped at as low a velocity as that from colliery A, then the dust from colliery B might have been more explosive than that from colliery A. It is clear then, that all dust should be classed by its velocity of suspension, or otherwise any tests made with it will give varying results, according to the velocities from which it has been dropped. Again let us notice that the $12v$ contains all the grades that preceded it as, $1v + 2v + 3v +$ etc., + etc. Or to put the matter clearly $12v$ must be considered an addition to all the grades of dust below it. Now we have a guide by which we can direct our judgment to right conclusions.

103. The Deposition of Coal Dust.—Fig. 141 still further develops the idea of a correct classification. A current passes along the drift E with a velocity of $12v$ or 12 feet per second, and suppose it holds in suspension d_1, d_2, d_3, or by the present classification $3v + 6v + 12v$. Now let the current split into two airways whose sections are equal to that of E, and it is clear that if the velocity in each of the splits is

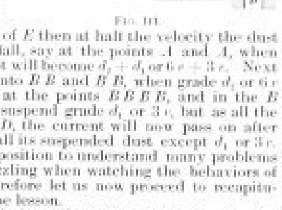


FIG. 141.

taken as half that of E then at half the velocity the dust of $12v$ grade will fall, say at the points A and A, when the suspended dust will become $d_2 + d_1$ or $6v + 3v$. Next let A and A split into B B and B B, when grade d_2 or $6v$ will deposit, say at the points B B B B, and in the B splits the air will suspend grade d_1 or $3v$, but as all the splits reunite on D, the current will now pass on after having dropped all its suspended dust except d_1 or $3v$. We are now in a position to understand many problems that would be puzzling when watching the behaviors of coal dust, and therefore let us now proceed to recapitulate the facts of the lesson.

104. Recapitulation of Facts.—Ques. 1. Is the velocity of a wind blowing along a road as high near the ground as above it?

Ans. The wind on striking the uneven surface of the ground is reflected and deflected, and therefore a stratum of the current near the ground has a lower velocity than at a higher elevation.

Ques. 2. In looking at the dust as it rises above the ground, what do you observe?

Ans. I observe that the cloud is more dense at the bottom and charged with large particles that do not rise more than two or three feet and then drop or are swept along at a low level.

Ques. 3. What do you observe at the top of the dust cloud?

Ans. I observe that the particles are very minute and moving in advance of those near the ground where the velocity is lower.

Ques. 4. In what respect is the mixture of sizes of particles different at different elevations?

Ans. At low elevations large and small particles are mixed, whereas at higher elevations only particles of a small grade are seen.

Ques. 5. How is the water dust of the clouds suspended?

Ans. The particles of water dust in the clouds are supported by their relatively large surface areas of suspension and are subject to the operations of the same laws as all other dust particles.

Ques. 6. Of what are you reminded when you look at the cirrus, the cumulus and the nimbus clouds?

Ans. I am reminded of the fact that as the cirrus clouds are suspended in an atmosphere of about half the density of the air resting on the earth, the particles of water dust that compose these clouds are like the very fine particles of coal dust suspended in nearly still air, and that the particles of a cumulus cloud are like particles of coal dust that can only be suspended by swift air currents, and that the particles in a rain cloud are unsuspendable in the reduced velocity of the wind, like the heavy coal dust that only rises with the shake of a passing train of mine cars.

Ques. 7. Is there any law associated with the peculiar appearances of the convolving clouds of steam escaping from the exhaust pipe of a steam engine?

Ans. Yes, there is a law relating to the stratification of the water dust of the condensed steam, and it is this, the larger particles arrange themselves like a tail projecting from the bottom of the cloud, and thus the cloud is sometimes bifurcated and and at other times trifurcated, according to the prevalence of the grades of the particles.

Ques. 8. How may different grades of dust be classified?

Ans. Different grades of dust may be classified according to the velocities by which they are suspended, as $1v$, $2v$, $3v$, etc.

Ques. 9. What is the object of these lessons on coal dust?

Ans. The object of these lessons on coal dust is to explain three of the characteristics of coal dust, and the first shows what coal dust is, the second shows how the particles of dust are suspended in air, and the third shows how particles of different sizes are suspended by different velocities of the air currents.

Ques. 9. How should samples of coal dust be obtained to test their explosive character?

Ans. Samples of coal dust from different mines should be collected on the floors of airways where the ventilating currents are moving with the same velocities.

(*To be Continued.*)

Mining in the Caucasus.

The immense supplies of foreign capital which have of late years been made available in Southern Russia, have also brought into prominence the mineral possibilities of the Caucasus, which were hitherto generally overlooked. Several new ventures are at present in more or less advanced stages of installation, and more are under contemplation. One syndicate is going in for quicksilver mining, and at its instance the various deposits are being examined and reported upon by an expert. The Crown works at Tachatoch will again be put in operation, and mining researches are to be instituted in various quarters. Touching upon the question of the desirability of an increase in the duty on zinc and lead ore, owners of Caucasian mines urge that they have never applied for this, and that they do not require it. The ore deposits are so easily accessible that no such protection is needed; what they require is an improvement in, and an extension of, the means of transport, which are almost everywhere inadequate, and in many parts almost *nil*. This cannot be done by private initiative, and it is expected that the government will ere long move in the matter. There are several striking examples of excellent ore deposits remaining literally unbroken for want of means of transport. At the Deyechra mountain, for instance, there are vast deposits of zinc and lead ore right on the surface which cannot be utilized, although the distance from the Black Sea (the Gudaupy port) is only 22 miles, but in order to get to the coast, a mountain ridge of 8,000 ft. in height has to be passed. What is required is a tunnel two miles in length, but, so far, no money has been forthcoming for this purpose. Similar instances might be mentioned where the absence of railroads or other means of communication almost completely stops the development of mining in various parts of the Caucasus.

A New Scoop Bucket.

Spencer Miller, engineer of the Lidgerwood Mfg. Co., New York City, has recently had a patent granted him for a novel form of scoop bucket, which has been thoroughly tested and has proved entirely satisfactory in loam and sand. It is employed on a cableway. The bucket is lowered to the toe of the sandbank and the carriage is run ahead so that the draw of the hoist rope is approximately parallel with the slope of the bank and the bucket is drawn up, thereby filling it. If the material be soft, the bucket will fill without guidance, but in harder material the bucket has to be guided by a man following it. The bucket is then conveyed back to the place of dumping and by virtue of lowering the bucket it is overturned and the load spilled. Mr. Miller has also had another patent granted him for a novel form of aerial dumping device.

Coal Washing Machinery.

Mr. Walter M. Stein, of Stein & Boericke, Ltd., 325 Walnut St., Philadelphia, informs us that his firm has recently closed contracts for a very complete coal washery of 300 tons capacity for the Jamison Coal Co. of Greensburg, Pa., and for remodeling a 300 ton lignite briquette plant for the Texas Briquette and Coal Company of San Antonio, Texas.

MISCELLANEOUS.

BENARES THE ANCIENT.

Five and twenty centuries ago, when Rome was not yet on the records of the world, and when Athens was in its infant splendor, Benares, on the noble Ganges, exerted a mighty power and her fame was established among men. Here the great Buddha proclaimed his doctrines first, sending forth missionaries from this center to Ceylon, China, Japan, Burmah, and Thibet, bringing in time nearly half the race of man under the influence of his teachings. But centuries afterward, during a powerful religious and political upheaval, Buddhism succumbed to Brahmanism, leaving behind only the ruins of its tones and temples. And to-day, what Mecca is to the Mohammedan, Jerusalem to the Christian, Benares is to the Hindoo.

The city is located along the crest of a hill, over 100 feet above the sacred Ganges. For three miles on the sloping west bank, palaces, temples and mosques, surmounted by domes, pinnacles, and minarets, rear their irregular tops. Giant flights of stone stairs, interrupted by wide platforms, on which are built shrines of every description, reach to the water, and on the edges of the bank are bathing ghats, which are crowded with pilgrims from every part of India, and from other countries, in every stage of dress and undress, whose supreme desire is to plunge into these holy waters before death overtakes them. These pilgrims are not all from the lower or middle classes, but include every rank of Indian society, from the elaborately dressed rajahs, followed by long retinues of attendants, to the unsightly looking ashes-covered fakir and the miserable deformed beggar, and from the little boys and girls to the aged grandfathers, lifted by bearers to the stream, all bent upon dipping in the mother Ganges for the remission of their sins.

Many of the women and girls carry wreaths of white and yellow flowers into the river, and as they most devoutly turn their faces toward the rising sun and inaudibly whisper their prayers, the garlands are broken into pieces and scattered upon the river. Hundreds of these devotees are seen with brass jars and other vessels, in which they carry away to their distant homes some of the holy water, and employes of the temples from central and southern India are there with their leather water bags, which are to be filled and borne on the backs of pedestrians for scores and scores of miles to their houses of worship.

Along the river bank there are not less than fifty of these ghats, which have for their background magnificent flights of steps leading up to imposing castles and palaces, great white mosques and soaring minarets. The Panchganga ghat, where five rivers are supposed to meet underground, leads to the noble mosque which the iconoclast, Aurangzeb, built on the site of the noted Krishna temple, which he destroyed.

This is the finest mosque in Benares, the foundations of which rise from the bed of the river in huge stone breastworks, which support the four walls and domes of the mosque, and springing lightly in the air are two graceful minarets, lifting the whole structure 300 feet above the swarm of bathers at the water's edge. In sailing up the river you pass the ghat where Vishnu dug his famous well, where Brahma made his celebrated sacrifice of ten horses, the Golden Temple, and many other spots that have made the city known the world over.

In the midst of these places of worship is located the Burning Ghat, where bodies are brought from all over India to be bathed in the Ganges, and then cremated on its banks. Smoke from four pyres was seen as we approached the ghat, and several corpses, wrapped in white cloth and lashed between two stout sticks, were being washed in the sacred stream, while the relatives of the dead were preparing the wood near by for the cremation. Bedecked with flowers, and sometimes wearing jewelry, the bodies are lain between layers of wood, the ashes are cast into the water, and we saw a number of men at work, who make a regular business of searching the shore and filtering the water through baskets in search of jewels or money that perchance might have dropped from the dead.

One of the most curious places visited was the Durga, or Monkey Temple. Durga is thought to delight in all kinds of bloodshed and destruction, and while we watched the worshippers, a man approached the blood-bedabbled altar in front of the shrine and, having placed a number of coins in the hands of the officiating priest, was given the privilege of having a little kid that he held under his arm beheaded, and after the sharp blade had descended he made an offering of the head and carried the body away to his home.

In the yards and trees about the temple are hosts of monkeys, who spring into your pathway, peer around the walls, snatch at your clothes, and make the most comical grimaces at you on the least provocation; but it is a crime to molest them, for they are gods and goddesses, held in the highest veneration. I could hardly suppress an irreligious laugh as I watched one of these goddesses, holding a baby god under her left arm, while she held a nut in her right hand, on which she was nibbling in the most human fashion, and during the whole performance she was making the most unholy faces at me because of my inferiority.

What the monkey is to Vishnu the cow and bull are to Siva. To slaughter these animals is a horrible crime, and in every part of India can be found temples dedicated to their honor, where they are kept with the greatest care.

One of the curiosities of humanity is the "holy man of Benares." His long continued acts of penance have worn his body to skin and bones. He is thought by many to be above all passion and sin; he declines to receive anything from visitors, and his bright eyes, sweet expression, and soft voice seem to indicate that he possesses a serenity in life that is enjoyed by few. His name is written Matparamahausaparinrajakacharyaswamibhaskaranandasaraswati!

To those who enjoy examining curios and artistic manufactures, the bazars of Benares will prove to be especially attractive. The city is famous for its beautifully engraved brasswork; and trays, water vessels, bowls, lotus dishes, candlesticks, lamps, fancy boxes, bells, spoons, and scores of other utensils, engraved most exquisitely, can be purchased for remarkably cheap prices. Rich brocades wrought with figures of animals in gold and variegated colors, the oldest survival of ancient loomwork extant and the finest of its kind in the world, are found in the tiny shops in the bazars; and this beautiful work is done by experts who receive about three or four dollars a week. When a piece is finished it is "worth its weight in gold," but the poor fellow whose genius created the masterpiece lives and dies in poverty, while some merchant in Europe or America gets the "weight in gold."—*Baltimore Sun.*

MAKING FOR THE HYDRANT.

To the bystander who sees a fire engine come dashing up to a hydrant it might easily seem, from his confident manner of approach, as though the driver had known from the start just what hydrant he was to take and had been all the time making for that particular one. As a matter of fact, the driver starts out of the engine house without knowing what hydrant he is to take, and he may not know until he is within a few seconds' drive of it. Still there is never a moment's uncertainty about the engine's movements, and it never slows down; it goes straight for the hydrant without the slightest delay. In answering ten calls from the same station, an engine may take as many different hydrants; but it goes to the right hydrant every time, and the manner of determining what hydrant it shall take is extremely simple.

Every engine hooks up at every alarm. On first alarms it goes out only to fires within its own district. When an alarm is sounded the horses rush to the engine, a catch or two is snapped, and the team stands hooked up ready to start; it is all the work of a very few seconds. But the harness is still held by the hanger from which it is suspended, not to be let go unless the call is one which the engine answers. The driver is up. With the last stroke, if it calls this engine, the captain says "go." Just a slight twitch of the reins frees the harness from the hanger, and it drops into place on the horses' backs. If it is in winter, the door is thrown open; if in summer, the chain is dropped, and away goes the engine, with the horses on the gallop, in the direction of the station whence the alarm has come, but without anybody knowing what hydrant it is to take.

The only man besides the driver who rides on the engine is the captain of the company or the officer in charge; he rides standing on the rear of the engine. All the rest of the company ride on the tender. Two blocks away from the signal box the captain jumps to the ground and runs ahead of the engine to locate the fire. He may find it before he comes to the box, or it may be beyond it. The location of the fire may be revealed by flames or smoke, or, perhaps, by the presence of people standing in front of the building in which the fire is, or by persons in the building itself. It may be that there are no such indications; that there are no visible indications whatever. But almost invariably the policeman or whoever gave the alarm remains standing by the box until the first engine comes up. He knows just where the fire is, and from him, in case he has not discovered it himself, the captain learns its location in an exceedingly brief space of time.

It may be around the corner. A wave of the captain's hand, as he starts on again, is enough for the driver, who has all the time kept coming. Then is the time when the bystanders in the side street might easily imagine that the driver had known from the start just what hydrant he was to take; for he sees the engine come tearing around the corner, the driver calculating the turn with the greatest nicety and straightening up and coming down the street booming, making for that hydrant as though he had never dreamed of taking any other.

The simple fact is that, the fire having been located, he is taking the hydrant nearest to it; it is always sought to take the hydrant nearest the fire. He comes up with a rush, firemen yank off a suction pipe and connect the engine with the hydrant, and the engine is ready for business. The captain is in the building. He sees at a glance whether water is needed; if it is, he orders a line of hose stretched and then begins the work of putting out the fire.—*N. Y. Sun.*

REPTILES OF THE DESERT.

From the standpoint of a zoologist there is probably no class of animals so characteristic of the desert as the reptiles. True, there are numbers of birds and mammals found all over the arid wastes of sand, but these either migrate or spend most of their time underground, as is the case with most of the smaller mammals. The birds choose the sheltered canyons, where, perhaps, a few drops of water will ooze out from between the rocks, or even venture out into the great sun-baked plains, seeking the shelter of the bushes and stunted trees which here and there manage to eke out an existence. The smaller mammals are almost all nocturnal in their habits and only venture out after nightfall when the earth begins to cool a little, and, with the exception of, perhaps, a few coyotes or the little desert fox, one may travel for hundreds of miles through the deserts without seeing a single animal except the reptiles and insects. The burning sands and the copper skies seem to have no terrors for them. At nearly every step one seems to awaken a fresh lizard from his rest under a bush or beside a stone, and away he goes, scurrying along over the sand, perhaps his long tail dragging in the sand, but more frequently elevated high in the air. In fact, this uplifted tail often looks like a little gray twig moving rapidly along the ground, but always retaining its upright position. And these lizards can run, too. In a twinkling they are gone, and then it is only the practised eye that can see them, for when they lie at rest their dull gray color makes it almost impossible to see them.

But these are not all; often from the side of the road, disturbed by the passing traveler, a horned rattlesnake or sidewinder will move sluggishly away, but ever keeping up an incessant rattle. Again, big sluggish lizards are found, nearly always a dull gray above, but beneath or around the head iridescent in the most gorgeous colors. And, too, the big tiger rattler of the desert canyons, though a trifle more sluggish than the sidewinder, seems ever ready to call attention to his bright colors by sounding the terrible rattle which strikes fear to the heart of any animal, no matter how large or how small. The tiger rattler is found in the desert regions of America, and is comparatively rare, being found only in the canyons of the barren ranges which traverse the desert in all directions. Though very dangerous, and sometimes growing to four feet in length, it cannot compare in viciousness with the little sidewinder or horned rattlesnake. The sidewinder prefers the open desert in which to live, and may often be found lying quietly beside some desert bush, waiting for its prey. It gets the name sidewinder from the fact that, in moving along the ground, instead of pursuing a straight course, it has besides the forward movement a sidewise, crab-like motion. It is much less sluggish than the other rattlers, perhaps on account of its small size size, as it seldom exceeds a foot and a half in length. It is lighter colored than the other rattlers, and directly over the eyes are protuberances, which give it the name horned rattler. It seems to be the most dreaded of all snakes by the desert traveler, probably on account of its being so hard to see owing to its small size and quick movements. In fact, it is about the only reptile which the desert prospector really dreads.

One of the most plentiful of the lizards which live on the desert is the blue-spotted lizard. It is about eight inches long and of a light ashen color on the back, but down each side runs a row of black spots, extending out on the tail. It receives its name from the two sulphur-blue patches, one on each side of the abdomen, and the little blue spot on the chin. One variety is blue nearly all over, giving out beautiful iridescent metallic colors. Probably the most characteristic of the lizards of the lower desert regions of California is the long-tailed or gridiron-tailed lizard. This species is found nearly everywhere in the lower parts of the desert and never fails to attract the attention of the traveller by its exceedingly rapid movements and its very strange habit of carrying its tail curved up over its back. In fact, the tail is the largest part of the animal, being longer than the head and body together. The movements of this little gray lizard are so quick as to make it hard for the eye to follow, and when it shoots off along the sand, with its tail high in the air, it looks almost as if a stick, standing on end, were scurrying away.

There is, living in the mountainous parts of the Mojave desert, a very strange lizard, which often reaches a length of over a foot, and which is nearly as wide as one's hand and of a uniform dark slate color, or even black, while the tail is spotted with white, and often nearly uniformly white. At a distance this species looks like a Gila monster, and many people, unacquainted with the latter, have supposed them to be the same, and I think it is due to this mistake that many people believe the Gila monster an inhabitant of California.

There is a very pretty and withal a very strange lizard found in several localities in the Mojave desert, which has been named by scientists "dipsosaurus dorsalis," on account of its near resemblance to the ancient saurians, which inhabited the earth many hundreds of years ago. Until the last few years it was not known that this strange lizard lived further north than Lower California, but recent explorations have proved that it inhabits the desert region as far north as the Panamint Mountains, in Inyo county. It has a thick, finely scaled neck and heavy legs, which support a rather clumsy body, and a long, tapering tail. The body is beautifully mottled, while the entire length of the tail is covered with transverse bars. The under surface of the body is whitish, while blotches and lines of red on the shoulders and sides, with the white spots on the sides, make it a very pretty lizard. The tail is longer than the head and body together, the total length over all measuring nearly fifteen inches in an adult male.

There are at least three species of horned toads living in California, one on each side of the Sierra, but the one that is found on the west and which is so well known to every boy in California, has been found so near the eastern borders of the Sierra foothills as to be almost included as one of the reptiles inhabiting the desert. The third species never gets into the Sierra. In general appearance the desert species is very similar to the one found in the inland valleys, but is of a lighter color, and the arrangement of the scales is somewhat different. The color may vary, however, from a dull white to a vivid brick red.—*From the San Francisco Chronicle.*

A WORD WITH THE DOCTOR.

The moisture of the eye is a genuine solvent. Many persons have gone to bed troubled with a foreign substance in the eye, and have waked up in the morning to find it gone. In many cases of this kind the foreign matter has been dissolved by the moisture of the eye.

⁂

All decay of the teeth begins from without.

Consequently, if the teeth's surfaces be kept scrupulously clean they cannot decay.

When ought cleaning begin?

As soon as there are teeth.

Let the child early acquire the habit of using a small toothbrush dipped into chalk flavored with some aromatic drug and let it understand that the places most needing the brush are those between the teeth.

This is the place where decay almost invariably appears.

Mucous secretions and secretions of food are always found between the teeth after a meal. They may be removed with a toothpick.

⁂

It is almost an art to use a toothpick. One must beware of injuring the fleshy parts and leaving splinters, which in some cases may cause the loss of a tooth. Metal toothpicks should be altogether avoided. Those of dull and hard wood are best.

⁂

There is no better aid to digestion, in certain cases, than the cooked apple. It is a recognition of this truth—though doubtless the recognition came before the truth was fully appreciated—which assigns apple sauce as an accompaniment of roast pork, goose, and other rich meats, which are apt to make trouble with the digestive powers. The derangements arising from eating too freely of meats, of almost any kind, are corrected by the use of an apple regimen, the fruit being used either cooked or raw. Paradoxical as it may sound, the free use of fruit acids, of which the apple is the very best repository, tends to decrease that very common disorder, acidity of the stomach, the chemical action of the related elements changing the acids into alkaline carbonates, which tend to neutralize any acid condition of the system.

⁂

Soap used on the hair is apt to make it brittle. If any is to be used, tar soap is the best, and after using, rinse the hair in several waters in which a little powdered borax has been dissolved.

⁂

Sometimes adults, but more frequently infants, are troubled by hiccough to a distressing degree. Take a teaspoonful of granulated sugar, and moisten with cider vinegar, and, for an infant, give small portions at a time, and the trouble will very soon disappear.

⁂

There is but one way of getting rid of blackheads, and that is by forcing them out of the clogged pore. But in pressing them out before the skin is properly softened and prepared for their ejection the patient ruptures the delicate tissue, causing either an ugly little scar or, more likely, an enlargement of the opening, which immediately fills up again, each time increasing in size and more malignant in appearance. Blackheads may not only be removed without leaving any scar, but once rid of, the patient need never again be troubled with them if he will carefully follow directions. For two or three weeks, until the skin is thoroughly softened, apply a cream or ointment at night after scrubbing the face with soap and water. Be sure to rinse the soap well out of the face. Dry thoroughly before applying the cream or ointment. Where the blackheads appear in the back and also between the breasts, the same treatment is required. Friction, combined with an emollient, is death to blackheads.

⁂

Perspiration of the feet sometimes amounts to almost a disease; and, when this is so, they should be bathed, night and morning, in soda and water, or water with the addition of one of the many disinfectants, and afterwards powdered with equal parts of powdered alum, tannin and boracic acid. The stockings should also be changed daily.—*From The American.*

THE MESQUITE TREE.

It is a common saying in the arid regions of the southwest that the natives climb for water and dig for wood. This being interpreted means that the water for drinking purposes is kept in an earthen jar, or olla, upon the top of the house, where, by means of the more rapid evaporation, caused by this direct exposure to the sun's rays, the contents of the jar are kept continually cool. And the digging for wood is explained by the fact that the only timber through much of that region is the mesquite, a low-growing shrub rather than tree, the roots of which are very hard and make an excellent fuel. For a whole winter I have been warmed by them, broken into little pieces, for they are too brittle to chop, and have found that they give out an amount of heat that is in undue proportion to their bulk.

The mesquite groves are a striking feature of the wide, level expanses of these regions. From a distance they look like peach orchards, only their vast extent precludes the idea that they are such. As timber a man accustomed to living among real forests would hardly give them a thought, but they are very much better than no timber at all. When in New Mexico recently I found that the tree had another use besides that of supplying fuel. It produces a bean which is an important article of food among the Indians, and in times of scarcity with the Mexicans as well. The bean is produced in pods which are seven to nine inches long, and of a buff color. They begin to ripen in midsummer, and as they have the quality of preventing thirst as well as of satisfying hunger, they are often of the greatest value to travelers through the desert country. The Indians, who know their value, do not hesitate to go a long distance away from water if they can be assured of a supply of mesquite beans along their route.

When used for food the beans are prepared in various ways. When fresh and newly ripe they are put into a mortar of stone or wood, and bruised, then emptied into an earthen dish, mixed with water and allowed to stand for a few hours. The result is a kind of cold porridge or mush, which has a very agreeable blending of sweetness and acidity, and upon which many of the people would willingly exist the year through. As the fruit or bean pods ripen they are gathered for winter use, thoroughly dried and stored in cylindrical-shaped baskets, made of twigs, and covered with grass or earth to keep the rain out. In this way they may be preserved for a long time. When needed for food the pods are reduced to a fine powder, by means of a mortar, and this flour cooked as fancy may dictate. The flour thus prepared is also often kept for a long time, sometimes in its pulverized state, and again by being mixed with a little water, and then pressed into large cakes of several pounds weight, which are dried in the sun and put away until needed. Among certain of the less civilized of the southern tribes of Indians, such as the Cucupahs, who live along the Colorado river in Lower California, the mesquite beans form an important part of the winter food supply. The only labor needed to secure them being that of gathering the crop, they appeal especially to these indolent people, who are constitutionally opposed to the labor of cultivating a crop. The mesquite has also other uses besides those of supplying fuel and food, as Indian women make rope and twine of the bark and weave it into baskets.

Horses and cattle feed upon the beans, which are very nutritious, and often find sustenance, and, indeed, the very means of keeping alive in them, when grasses of all kinds are burned up by the drought.—*New York Independent.*

NATURE'S PLAN OF DISTRIBUTING PLANTS WITHOUT THE AID OF MAN.

The terrible eruption of Krakatoa, in the Sunda Strait, in 1883, furnished the opportunity for illustrating the ease with which nature can replant with vegetable life a district that has become completely desolated. The volcanic eruption was one of the most destructive recorded in history, the loss of human life being estimated to exceed 100,000. Of the thirty-five volcanoes on and near the Island of Java, twenty-six were in violent eruption at the same time. The center of disturbance was the island volcano of Krakatoa, which emitted molten lava and burning ashes in such abundance that everything living, whether animal or vegetable, on the island was destroyed, and an observer from a ship which approached close to the land declared that the whole island was red hot. Four years from the date of the eruption the island was visited by an eminent naturalist, who found that the ashes and lava had cooled to such an extent as to permit the beginnings of vegetable life, and on making a closer examination he discovered that during the brief space of four years nature had stocked the island with 246 different kinds of plants.

There are many seeds which seem, by their formation, to be specially designed for transmission through the air, and of these several are quite as good illustrations as the thistle. The seed of the common dandelion, a plant to be seen on every common, has wings which will carry it away on the slightest breath of air. The wings are very slight filaments, radiating backward from the seed, so that, when the latter finally lodges, it falls tip first, in the most favorable position for taking root. Country children in the United States often find amusement in blowing the seeds from the stalk and watching to see how far they will go before falling to the ground, but whenever there is even a moderate breeze the experiment is uniformly a failure, as the fleecy seeds fly out of sight and are gone in an instant, and the next season a dandelion springs up in somebody's lawn, where the plant was never seen before. The common tumble weed is another example of the winged seed. The plant grows in a woolly bunch, which, when dried, is easily separated from the stalk, and a light breeze sets the ball rolling over the ground, to scatter its seed wherever it goes.

The seeds of many ferns and microscopic plants are so constructed as to be readily lifted and carried away by the wind, while some of considerable size are provided with an elaborate arrangement for aerial transportation. The common maple is an example of the last kind, for projecting from its large head is a membrane closely resembling in size, shape and general appearance the wing of the locust. When the seed is separated from the tree, even if the air be quite still, it does not fall directly to the earth, but, by its peculiar construction acquires in falling a spiral motion that takes it several feet from beneath the starting point, and when a brisk breeze is blowing one of these winged seeds has been known to twirl through the air for six miles before its journey came to an end and it sank to the ground, there to germinate and start a maple grove.—*From the St. Louis Globe-Democrat.*

RESIDENCES IN PALESTINE DURING ITS GREATEST PROSPERITY.

The town houses of Palestine varied in extent and splendor with the circumstances of their inhabitants, from the humble cottage to the larger dwellings of the patricians. The walls were built of bricks, of half-bricks, of dressed and undressed stones, and even of white marble, or large hewn stones. These stones were cemented together with mortar, gypsum, and even asphalt. Sometimes they were, besides, riveted together with iron or lead, but in such a manner as to be imperceptible. The walls were covered with a kind of whitewash, and palaces were painted in delicate colors. The woodwork was constructed generally of sycamore (the most common tree in Palestine), sometimes of olive and almond trees, now and then even of cedar, and adorned or inlaid with ivory or gold. Richer dwellings were distinguished by rows of pillars and other architectural ornaments. The houses of the better classes consisted generally of two or more stories, to which a stair, often costly, conducted from the outside. From the various uses made of the court, which also served as a kind of antechamber to visitors, it is clear that it was a most important part of the building. It varied in size with the circumstances of the tenant, being sometimes divided into an outer and inner court; at other times it was shared by several tenants. The inner court, whence the porter opened to callers on their names being mentioned, often led into a large and splendid reception room, from which other apartments led to the interior of the house. The upper rooms were not used for common purposes; inner rooms were inhabited chiefly in winter. The apartments were often richly decorated, sometimes painted, or covered with pictures. The reception room and inner court properly formed together but one apartment. It appears that the inner court was paved, was surrounded by galleries, and sometimes had fountains and baths. The roofs, although ostensibly flat, were, in fact, somewhat sloping, to allow the rain water to flow into the channels and cisterns, paved with stones or with earth beaten hard, and surrounded by a protecting balustrade. When great privacy was sought, as in prayer, the roof was used, especially when upper rooms were wanting, and, in the cool of the evening, the roof was the place of chief resort. It was also employed for domestic purposes, such as drying fruits, etc. The floors of the room were of gypsum, and even of marble; the doors were sometimes of stone, but more frequently of wood, and moved on hinges let into sockets above and below. They were barred by wooden bolts, which could be withdrawn by check keys from the outside. The dining apartment was very spacious and was often employed for assemblies. Instead of glass panes the windows had gratings or lattices. They mostly looked into the streets and were distinguished as Tyrian windows, probably large, or Egyptian, which are supposed to have been small, sometimes only two feet square. In the houses of the wealthy the window frames were carved, as in general was their furniture; the tables, couches, chairs, lamps, candlesticks, etc., were exceedingly costly. Among other articles of luxury may be mentioned soft cushions, destined to be placed under the head or arms.—*From a review of "History of the Jewish Nation After the Destruction of Jerusalem Under Titus," in N. Y. Sun.*

THE CAST OF A BELL.

The operation of casting a bell is a most interesting one. The flask whereon and wherein the mold is made consists of two parts constructed of boiler iron of a general bell form and plentifully perforated with holes for escaping gas while casting, one being so much less in size than its fellow as to give space for the loam forming around the mold between the two. No "pattern," as the term is generally used, is provided. The two parts of the mold are "swept" by "formers," accurately finished from thin iron to the form intended for the inner and outer surfaces of the bell. These "formers" are mounted and rotated over the applied loam. Five courses of loam and clay are successively applied, "swept" and baked, to complete each mold. Before this work is done, however, the inner flask is wound near the top with a rope made of hay. As the shrinkage is very great as the castings cool, difficulty would be met with in getting the flask and loam out of the nearly parallel inside top. This "pinch" is obviated by using this destructible base, which permits the collapse of the loam after the heat of the metal has consumed the hay.

The five courses laid on the flasks are: Loam, a mixture of loam, fire clay and manure; two successive coatings of powdered fire clay, and, lastly, a thin coating of brick and fire clay combined with foundry facing. Each of these coatings is baked in an oven before the succeeding one is applied. The coatings are "swept" by the formers, as applied, both in the inner and outer flasks, by careful adjustments as to thickness of materials, so that when the exterior mold is placed over the interior a space corresponding to the intended thickness and shape of the bell shall exist. Inscriptions or embellishments to be made upon the bell are provided for with the last coating by means of a "knurl," or wheel, having the desired motto raised upon its periphery, the wheel being carefully rolled around the soft surface and leaving its imprint in the clay. Other designs are impressed from dies of the required ornament, and the usual "beading" is accomplished by notches in the edge of the sweeps.

The two parts of the flask being placed together are firmly held in position by many clamps, the tendency of hot bell metal to squeeze through and force a separation of flasks being very great. As the mold nears completion a fire is started in a near by reverberatory furnace, in which is placed the desired charge of copper, and when the copper is melted the tin is added in its proportion. The melted metal being ready, the furnace is tapped, the bright stream caught in a huge ladle swung over the mold by a crane and poured into the open mouth of the mold until it is filled. After cooling and removal from the mold the bell is usually polished with sand and water in special revolving grinding machines. The tongue and clapper, the yoke and wheel are now attached and the whole suspended in its frame. In making a chime the bells are, after completion, temporarily set up and regularly tested by skilled bell ringers, from the permanent chiming stand of the foundry.—*Exchange.*

THE STRENGTH OF ICE.

The army rules are that two-inch ice will sustain a man or properly spaced infantry; four-inch ice will carry a man on horseback or cavalry or light guns; six-inch ice, heavy field guns, such as 80-pounders; eight-inch ice, a battery of artillery with carriages and horses, but not over 1,000 pounds per square foot on sledges; and ten-inch ice sustains an army, or an innumerable multitude. On fifteen inch ice railroad tracks are often laid and operated for months, and ice two feet thick withstood the impact of a loaded passenger car after a sixty-foot fall (or perhaps 1,500 foot-tons), but broke under that of the locomotive and tender (or perhaps 3,000 foot-tons.)

Trautwine gives the crushing strength of firm ice as 167-250 pounds per square inch. Col. Ludlow, in his experiments in 1881, on 6⅓-inch cubes, found 292-889 pounds for pure hard ice, and 222-820 pounds for inferior grades, and on the Delaware river 700 pounds for clear ice and 400 pounds or less for ice near the mouth, where it is more or less disintegrated by the action of salt water, &c. Experiments of Gasowski gave 208 pounds; those of others, 310-320 pounds. The tensile strength was found by German experiments to be 142-223 pounds per square inch. The shearing strength has been given as 75-109 pounds per square inch. The average specific gravity of ice is 0.92. In freezing ice increases in volume from 1.9 to 1.18, or an average of 1.11; when floating, 11-12 is immersed.—*From the Engineering Mechanic.*

SALUTING THE FLAG.

The respect of the navy for the flag—"Old Glory"—is partly expressed by a simple little ceremony which attends the hauling down of the ensign at sunset. One writer thus describes the saluting of the flag as it is taken in the moment the sun goes down.

The first time I ever saw it I was sitting on the quarter-deck of the United States steamer Yantic, conversing with three of her officers. We had been dining together, and were enjoying the cool evening breeze under the awning.

A few minutes before sundown a bugle-call sounded from the flag ship, and the call was immediately repeated by the buglers of the other ships of the squadron.

"What is that?" I asked.

"That's 'Stand by the colors,'" said one of the officers.

Two sailors came aft, cast off the ensign halyards, and stood by with their eyes on the flag ship. In a few moments we heard the bugles sounding again, for you must know that on board ship many of the commands are conveyed by a few musical notes upon the bugle. A marine came aft, and saluting, said:

"Haul down, sir."

"All right," said the officer of the deck, "sound off."

At that order the bugler of the Yantic blew the lovely call, "Evening colors."

The moment he sounded the first note the officers rose from their chairs, faced the colors, took off their caps, and stood silent, in respectful attitudes, while the two seamen slowly hauled down the colors, bringing them in over the rail as the call came to an end. When the colors reached the deck and were gathered in by the seamen, and the last note of the bugle died away, the officers put on their caps, resumed their seats, and went on with their conversation.

Removing the cap in honor of the colors is the common form of salute in the navy. When an officer comes up from below he always lifts his cap in the direction of the quarter-deck, and all the boys should remember, when visiting a man-of-war, that the proper thing to do when you go on board is to turn toward the stern of the ship where the ensign always flies at the taffrail staff, and raise the hat.

If the officer of the deck sees you he will return the salute, but whether any one is on the quarter-deck or not, always raise your hat when you go aboard. The salute is to the flag, not to any person, and surely every American ought to be proud to lift his hat to the flag of his country.—*From St. Nicholas.*

LATE SUPPERS.

The old tradition that to eat anything just before going to bed is sure to produce indigestion and render sleep impossible is now happily exploded. It is not good, as a matter of fact, to go to bed with the stomach so loaded that the undigested food will render one restless, but something of a light, palatable nature in the stomach is one of the best aids to quietude and rest. Some physicians have declared, indeed, that a good deal of the prevalent insomnia is the result of an unconscious craving of the stomach for food in persons who have been unduly frightened by the opinion that they must not eat before going to bed, or who have, like many nervous women, been keeping themselves in a state of semi-starvation. Nothing is more agreeable on retiring for the night than to take a bowl of hot broth, like oatmeal gruel or clam soup. It is a positive aid to nervous people, and induces peaceful slumbers. This is especially the case on cold winter nights, when the stomach craves warmth as much as any other part of the body. Even a glass of hot milk is grateful to the palate on such occasions, but a light, well-cooked gruel is better, and in our climate, during the cold months of winter, should be the retiring food of every woman who feels the need of food at night.—*From the Canada Lancet.*

TINY OXEN.

One of the greatest curiosities among the domestic animals of Ceylon is a breed of cattle known to the zoologists as the "sacred running oxen." They are the dwarfs of the whole ox family, the largest specimen of the species never exceeding thirty inches in height. One sent to the Marquis of Canterbury in the year 1891, which is still living, and is believed to be somewhere near ten years of age, is only twenty-two inches high, and weighs but 109½ pounds. In Ceylon they are used for quick trips across country with express matter and other light loads, and it is said that four of them can pull a driver of a two-wheeled cart and a 200-pound load of miscellaneous matter sixty to seventy miles a day. They keep up a constant swinging trot or run, and have been known to travel 100 miles in a day and night without either food or water. No one knows anything concerning the origin of this peculiar breed of miniature cattle. They have been known on the island of Ceylon and other Buddhistic countries for more than a thousand years.—*Tit-Bits.*

MAKING HOLES IN GLASS.

Strong glass plates are bored through by means of rotary brass tubes of the necessary diameter, which are filled with water during boring. To the water there is added finely-powdered emery. Thinner glass may be perforated with holes in an easier manner, by pressing a disk of wet clay upon the glass, and making a hole through the clay of the size required, so that the glass is laid bare. Molten lead is then poured into the hole, and lead and glass drop down at once. This method is based upon the quick, local heating of the glass, whereby a circular crack is produced, the outline of which corresponds to the hole made in the clay. When molten lead is poured upon clay so that steam is generated from the moisture, the lead is very apt to fly. Putty, although, of course, more expensive, is much to be preferred to clay for use in connection with molten lead.—*American Machinist.*

WHY AND HOW THREAD IS NUMBERED.

The question, "Why is spool cotton numbered as it is, and why are the figures not used in regular order?" is often asked. The explanation is this: The numbers on the spools express the number of "hanks" which are required to wind a pound. The very finest spinning rarely exceeds 300 hanks to the pound, while in the very coarsest there is about a half pound in each hank. The more common qualities, however, those from which sewing thread is usually made, run from ten to fifty hanks to the pound, and the spools on which it is wound are numbered from 10 to 50 in accordance.—*Boston Journal of Commerce.*

HORSE-POWER OF A LIGHTNING STROKE.

At Klausthal, in Germany, a lightning stroke struck the wooden post of a house and fused two nails four millimeters thick. Messrs. Siemens & Halske, of Berlin, afterward carried on a series of experiments to ascertain the force required to melt this quantity of iron. Assuming one second as the time standard, it required a current of 200 amperes and 20,000 volts, representing 7,000 horse-power. Assuming that the lightning occupied one-tenth of a second to fuse the two nails, the horse-power required would be 70,000.—*From Machinery.*

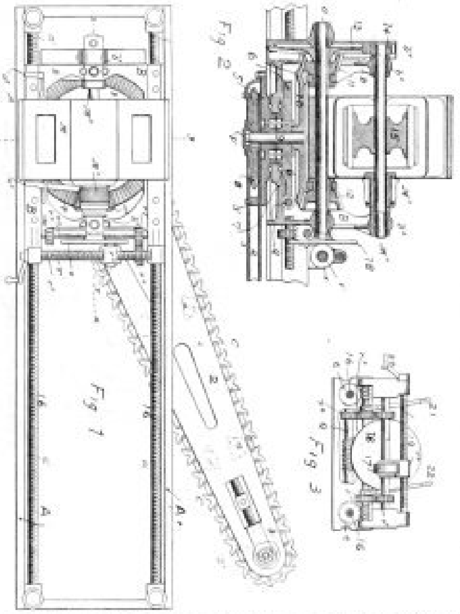
"This Indenture."

The phrase "this indenture" which is still frequently used in written contracts is probably unintelligible to most persons, since no one now "indents." Indenting a deed or contract consisted in cutting a zigzag line across the top of the document from one side to the other. All English deeds were formerly written in duplicate upon the same skin or parchment and separated by cutting them apart with a knife in the zigzag manner referred to. One of these instruments was given to each party named, and the fact that the two documents would exactly join each other was evidence of their genuineness.—*From the Albany Times-Union.*

NEW INVENTIONS.

MINING MACHINE.

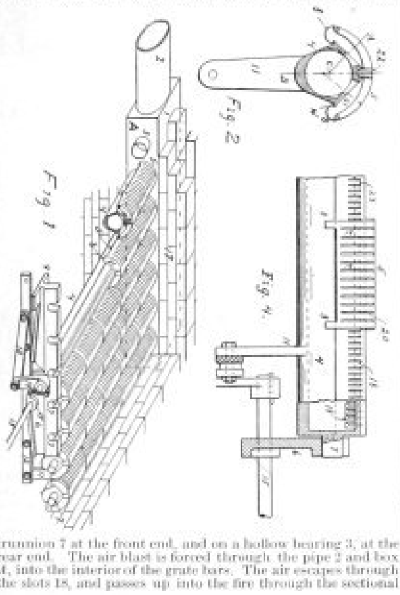
No. 555,832. ISLE A. STOREY, BOULDER, COLO. *Patented March 3rd, 1896.* Fig. 1 is a top view of the complete machine; Fig. 2 is a vertical section along the axis of the main shaft X X, and Fig. 3 is a front view of the feed gearing. The cutter chain is carried on an arm or boom 2, which is provided with suitable sprocket and guide sheaves 3 and 4. The boom is attached to center plates 5 and 6, which turn in a suitable bearing in the machine frame 7. The chain is driven by means of the sprocket 8, shaft 9, wheel 10 and pinions 11 and 12, shaft O, gear 13 and pinion 14, which is on the shaft of the armature 15. The pinions 11 and 12 are provided with levers by which they may be engaged so as to drive the wheel in either direction. The boom can be revolved around the shaft 9 by means of a worm Q, which engages teeth in the



edge of the wheel 6. The frame B, which carries all of the working parts, is moved along on the main frame A, by means of two worm wheels t, which turn upon the fixed screws 16, and act as nuts. Both of the wheels t and worm Q are rotated through suitable gears by the friction wheel 17, and the disc 18, which is attached to the end of the main shaft O. The rate of feed may be changed by shifting the friction wheel 17 across the face of the disc, by means of the screw 19 and handle 20. Thus the machine may be fed in either direction, or the boom may be swung around, together or separately as desired, by manipulating the feed levers, 21, 22. The cutter chain is provided with double faced cutters, which are designed to cut in either direction.

TUBULAR ROCKING GRATES.

No. 554,586. JAMES L. WHITE, WEST SUPERIOR, WIS. *Patented Feb. 11th, 1896.* Fig. 1 is a perspective view showing the general arrangement of the grate bars; Fig. 2 is a cross section of a grate bar; and Fig. 4 is a sectional side view of the same. Each grate bar is tubular, and is made to turn on a



trunnion 7 at the front end, and on a hollow bearing 3, at the rear end. The air blast is forced through the pipe 2 and box A, into the interior of the grate bars. The air escapes through the slots 18, and passes up into the fire through the sectional grates 5. These grates are made in small sections so as to be easily renewable, and they are provided with a rib 22, and hooks 8, which enable them to hold fast in position when the main bars are rocked. Each main bar is provided with an arm 11, by which it is connected to the raker shaft 15. The destructive action of the fire is limited to the grate sections 5, the main bars last a long time, not being exposed to the fire. The sections are easily removed through the furnace door, without taking down any part of the apparatus. The bars may be turned over far enough to remove ashes and clinker, or to dump the fire.

PUMP AND ENGINE VALVES.

No. 556,549. ARTHUR MARECHAL, BRUSSELS, BELGIUM. *Patented March 17th, 1896.* Fig. 1 is a cross section of a pump cylinder provided with these valves; and Fig. 2 is a lengthways section of the same. The valves E and D are made in pairs, and when in use, one forms a seat for the other. Both valves move, but in opposite directions; the necessary throw is thus one-half of that ordinarily required, and the opening or closing movement may be performed with great rapidity. These valves are especially valuable for blowing engines and

FIG. 1.

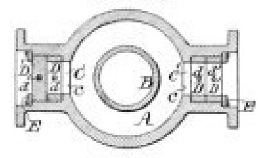
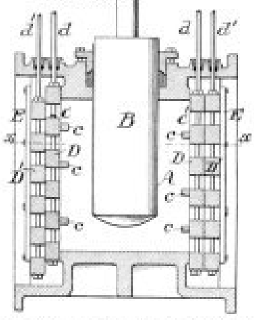


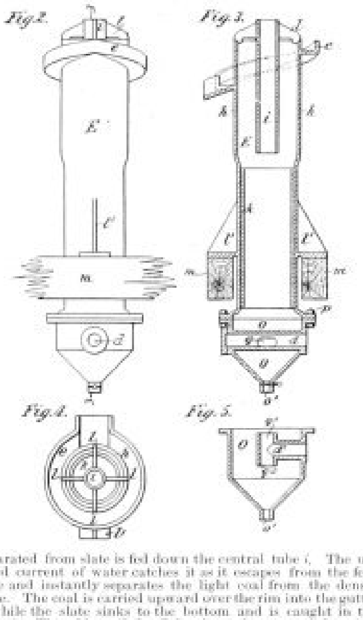
FIG. 2.



air compressors, and for use in triple expansion steam engines, etc. The drawing shows them, as used for inlet and discharge valves in a plunger pump. The bearing of the valves D upon the cylinder is only around the edges, and there are no ports or valve faces to be made on the water barrel or cylinder casting. Thus the construction of the castings is greatly simplified.

COAL WASHER.

No. 555,920. RUDOLPH BOERICKE, PHILADELPHIA, PA. *Patented March 10th, 1896.* Fig. 2 is a side view of the device; Fig. 3 is a vertical section, at right angles to Fig. 2; Fig. 4 is a top view, and Fig. 5 is a modified form of base or dirt catcher. A stream of water is introduced through the pipe d, and passes through the holes g into the base O, and upwards through the liner k and body E, to the top of the shell, where it overflows into the gutter e. The coal to be washed and

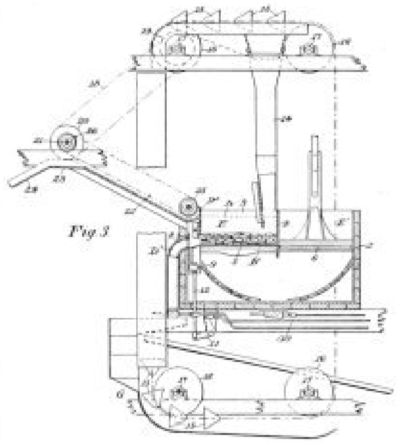


separated from slate is fed down the central tube i. The upward current of water catches it as it escapes from the feed tube and instantly separates the light coal from the denser slate. The coal is carried upward over the rim into the gutter e, while the slate sinks to the bottom and is caught in the base O. The object of the T head on the water inlet pipe, shown in Fig. 5, is to allow the force of the water current to be used to stir up and loosen the sediment which settles in the base, so that it can be readily discharged from the opening o'.

COAL JIG.

No. 556,739. ECKLEY B. COXE, DRIFTON, PA. *Patented March 24th, 1896.* The tank 2, is divided by a partition 4, into a working chamber E, and a pump chamber E'. The plunger 6 is moved up and down by suitable rods and cranks not shown, and the water which is beneath it is forced to surge up through the material in the working chamber, and back, at each stroke. The bottom is curved as shown to facilitate the movement of the water. The perforated plate 5 which forms the bottom of the working chamber, is covered with a layer B^1 of broken feldspar; the pieces being so

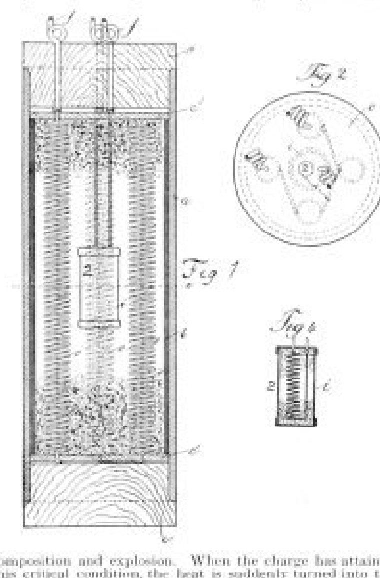
No. 556,739.



large that the water can flow through easily, and the refuse from the coal can make its way downward to the slate gate 8. The freshly broken coal is fed into the machine by the conveyor 15, through the chute 14, and the good coal is lifted by the pulsations of the water up to the tip of the discharge at D^2. Here it is taken up by the conveyor 22, and delivered to the chute 24. The slate and impure coal which is rejected by several of these jigs, is collected by a suitable conveyor and is treated in another jig of similar construction, and the little good coal still to be found among the refuse is thus finally removed.

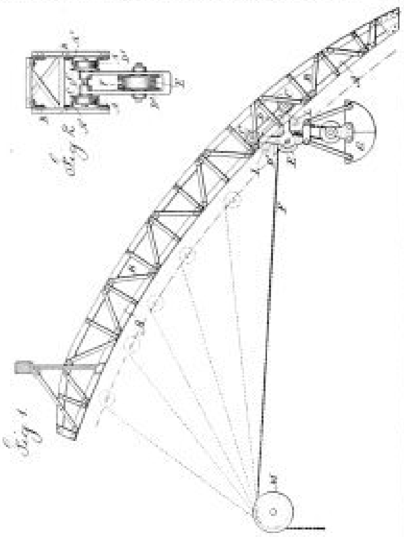
THERMO-EXPLOSIVE CARTRIDGE.

No. 556,901. CHARLES H. RUSH, CHICAGO, ILL. *Patented March 24th, 1896.* Fig. 1 is a lengthways section of a cartridge; Fig. 2 is an end view of the same; and Fig. 4 is a section through the igniter. The materials used for blasting by this process are non-explosive under all ordinary conditions, and the cartridges cannot be exploded by accident. They are filled with a mixture of about 15 parts by weight of chlorate of potash with one of paraffine oil. Other materials may be used, such as the nitrates of ammonia and potash, and manganese dioxide with powdered carbon instead of oil. The explosion is effected by heating the interior of the cartridge, after it is placed in the bore hole, to a temperature of about 400°. This weakens the chemical stability of the compounds and brings them to the verge of spontaneous decomposition and explosion. When the charge has attained this critical condition, the heat is suddenly turned into the igniter 2, which instantly detonates and precipitates the explosion of the charge. The time required for heating the cartridge may be varied from a part of a second to half an hour, to suit any variety of work, from artillery to slow blasting. The heating is done by means of electricity, which is sent through coils of German silver wire embedded in the material, and the igniter is fired in the same way. The material commonly used to charge the igniter is one part of soot mixed dry with five parts of chlorate of potash. This cartridge is well adapted to either simultaneous explosion in large numbers, or to single shot blasting. The materials are safe to handle both before and after they are made up into cartridges, and when cold, may be dug out of a drill hole with impunity.



COAL HANDLING APPARATUS.

No. 553,118. CHARLES W. HUNT, WEST NEW BRIGHTON, N. Y. *Patented Jan. 14th, 1896.* Fig. 1 is a side elevation showing the boom and hoisting apparatus, and Fig. 2 is a cross-section of the boom, upon a larger scale. The wheels of the trolley run between angle iron guides A, A^1, so that it cannot get out of place or become jammed on the boom. The



main sheave E is hung below the center of the trolley, and the bucket is thus underhung sufficiently to avoid striking the boom at any position. When the trolley reaches the lower end of the boom it is stopped, and the bucket descends vertically. In hoisting, the bucket rises until it strikes the trolley, after which both go up together. Thus the bucket is hoisted and carried horizontally to any desired distance, without a stoppage or pause of the hoisting engines.

MINING MACHINE.

No. 556,986. FREDERICK HURD, LONDON, ENGLAND. *Patented March 24th, 1896.* Fig. 1 is a top view, partly in section, of the machine at work, and Fig. 2 is a sectional end view of the same. The cutter bar employed in this machine is provided with a deep spiral groove throughout its whole length. The cutter bits are inserted in suitable sockets in the edge of the groove, and the end of the bar is armed with a pair of

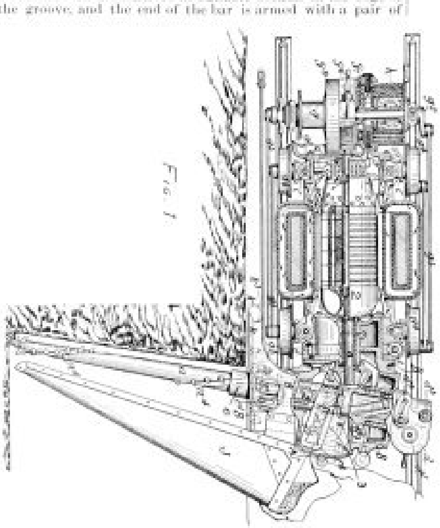


Fig. 1

Fig. 2

removable auger bits. The cutter bar passes through a rotating sleeve b, and is turned by means of a spiral rib, or feather, which engages the groove a^1. They are rotated by means of an electric motor 2, through the bevel gears b^1, c, and the shaft o. The head B, in which they are mounted, can be swiveled to any angle vertically by means of the worm i and worm gear i^1; or it can be turned over so as to reverse the machine from right to left hand, when desired. There is a feed pinion at d^1, which engages the circular teeth or grooves in the shank of the cutter bar, by which it may be fed into or withdrawn from the coal by hand feed. When the cutter bar has been entered to a proper depth, it is given a reciprocating movement in addition to its rotary motion, by engaging it with the chuck jaws e. These are reciprocated by means of the rods e^2 attached to the levers f^1, which are vibrated by means of cranks on the vertical shaft 3. This is turned by means of a worm wheel which engages a worm on the main sleeve b. Thus the cutters are given a shearing and rotary motion at the same time. The machine is drawn along on the tracks by means of rope and block, the rope being wound up by the drum g, which is slowly rotated by internal gearing g^3 and a worm g^4 on the forward end of the armature shaft. A quick motion, either way, is obtained by opening the clutch of the drum and coupling to the shaft, which drives the truck wheels by means of cranks g^5 and side connecting rods g^6. A scoop J having a conveyor inside of it follows close behind the cutter bar, and removes the chips.

MINING MACHINE.

No. 557,144. EDWARD S. MCKINLAY, DENVER, COLO. *Patented March 31st, 1896.* Fig. 1 is a top view of the machine; Fig. 2 is a vertical lengthways section, and Fig. 3 is a rear end view. The cutter bar H is of the ordinary revolving type which is armed with cutter points and is forced broadside into the coal. The shaft I carries suitable conveyer chains, not shown, which remove the chips made by the cutters. The shafts H and I are driven by chains W and X, from the shaft V, which is geared to the engine shaft T, by the wheels s, u, and t. The engines are back acting, the connecting rods passing backward along the side of the cylinders to the crank shaft at the rear. By this arrangement the cylinders and gearing are brought low down between the side frames, thus reducing the head room required to a small amount. The cutter bars and engines are attached to an inner frame composed of side bars D and cross girts P, O, N, and braces D^2. The engine frame can slide on this frame a few inches, and by adjusting the screws Q, the chains W and X can be kept taut as desired. The inner frame slides between flanges cast upon the sides of the tubular main frame A, and it together with the working parts, is fed forward into the work, or drawn back by means of pistons E in the cylinders A. The piston rods E are attached to the brackets F, which also support the shafts H and I. The pistons are driven forward by compressed air or steam admitted through the pipes J. The main frame is composed of the two cylinders A and the cross girts B, which are connected on the bottom by shoe bars B^1.

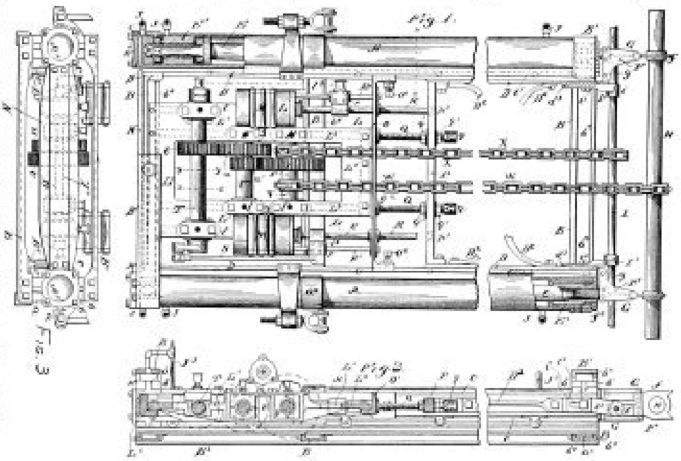


Fig. 3 — Fig. 1 — Fig. 2

GRATE.

No. 556,795. CHARLES YINGLING, METUCHEN, N. J. *Patented March 24th, 1896.* Fig. 1 is a top view of the complete grate; Fig. 2 is a sectional side view showing the grate bars in position for ordinary use; and Fig. 3 shows the positions assumed by the bars when rocked. Each bar rocks on trunnions which rest in pockets in the frame A, and the fingers of the alternate bars intermesh, as shown. The alternate bars are connected together by means of the links E, and the intermediate bars are rocked by means of

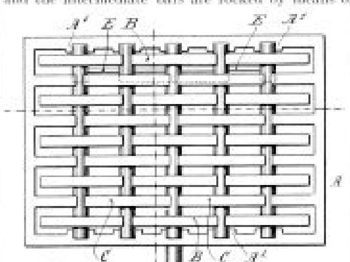


Fig. 1

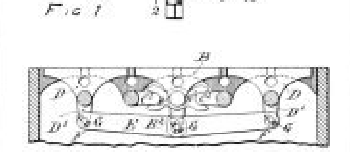


Fig. 2

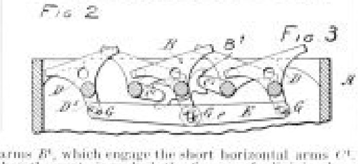


Fig. 3

forked arms B^1, which engage the short horizontal arms C^1. Thus when the grate is rocked, the fingers of adjoining bars are moved in opposite directions. The trunnions are located at a considerable depth below the normal surface of the grate, so that when the bars are rocked, the fingers have a horizontal motion, which tends to grind off the under side of the fire, in addition to the up and down motion. The bars at the side of the grate are tilted more than the middle bars; that is accomplished by making the arms D^1 a little shorter than the arms on the middle bars.

PLACING BLASTING FUSES.

No. 556,882. ROBERT H. ELLIOTT, BIRMINGHAM, ALA. *Patented March 24th, 1896.* Fig. 1 shows a fuse in position in a reamed powder chamber. Fig. 2 shows the device used to place the fuse in position. The wires are insulated for a short distance only back from the fuse H. The bare wires

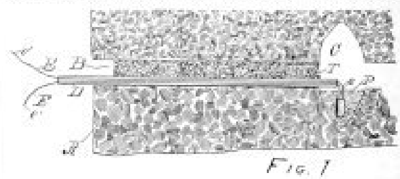


Fig. 1

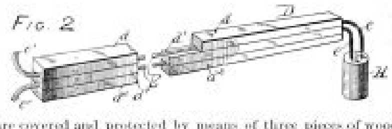
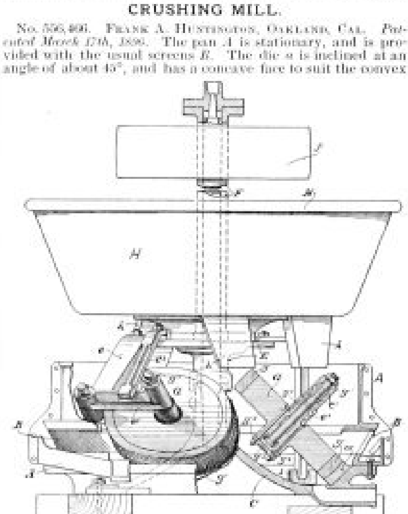


Fig. 2

are covered and protected by means of three pieces of wood d, d^1 and d^2, which are suitably grooved and lightly bound together into a stiff rod D. In practice the rod D is pushed into the bore-hole until the fuse H hangs down in the powder-chamber, as shown in Fig. 1. Then the explosive material is put into place in the usual way, ordinarily burying the fuse therein. Then the tamping material T is rammed in and the apparatus is ready for the blast. It will be seen that the rod D, being stiff and lying straight along the bottom of the bore-hole, will not interfere with the ready insertion of the blasting charge nor with the placing of the tamping material, which may be conveniently rammed into place without disturbing the wires, whereas when the wires are simply insulated by the ordinary winding and are laid in the bottom of the bore-hole in the ordinary way, the tools used in inserting the blasting charge and the tamping material are very likely to catch in the wires, displacing the fuse and rendering it liable either to act poorly or to fail to act at all.

CRUSHING MILL.

No. 556,466. FRANK A. HUNTINGTON, OAKLAND, CAL. *Patented March 17th, 1896.* The pan A is stationary, and is provided with the usual screens B. The die a is inclined at an angle of about 45°, and has a concave face to suit the convex



rim of the grinding rolls. The rolls are hung by swing links to arms e, which project from the driver E. Thus they are free to rise sufficiently to run over lumps, etc., on the die, and to swing outward in obedience to centrifugal force. The driver, together with the hopper H, is fastened to the sleeve F and turns with it. There is a feed spout N in front of each roller, and a scraper I in the rear. The roller spindles are capped and well protected against the entrance of dust into the bearings.

The Colliery Engineer

AND

METAL MINER.

VOL. XVI.—NO. 12. SCRANTON, PA., JULY, 1896. With Which is Combined THE MINING HERALD.

IRON AND MANGANESE.

THE GREAT CEBOLLA RIVER DEPOSITS.

The Location, Geology, Topography and Development of the Greatest Beds of Iron and Manganese Known in the World.

Written for THE COLLIERY ENGINEER AND METAL MINER by Prof. Arthur Lakes.

During a recent trip to Gunnison county, in northwestern Colorado, we visited and examined what we believe to be by far the greatest deposits of iron and manganese at present known in the world. The locality, as well as the deposits, have been but little known hitherto to the outside world, owing to their distance from the railroad and their not being near any considerable market. The locality is on the banks of the Cebolla, about a mile below a number of cold and hot mineral springs, over which a rustic "resort" has been located. The hills on either bank of the Cebolla (pronounced Cevoya) are capped with a light colored rhyolite lava, and dykes of the same occur cutting up vertically through the river banks, indicating the original sources or fissures from which the lava issued.

About a mile below the hot springs the lava cap on the east bank terminates abruptly at three lofty and somewhat cone-shaped hills, from 600 to 1,000 feet in height, 2½ miles in length, about one-half a mile wide, and their bases covering about 800 acres.

These hills are mountains of solid iron and manganese, mingled with crystalline calcspar. Their prevailing color is a tawny red; the upper parts are covered with fir trees. Behind them, to the west, and bordering on them, is a still loftier hill composed mainly of titaniferous iron. This hill is greyer looking than the others, and the line where the titaniferous iron ends and the manganiferous begins is exceedingly clearly marked by a line of color.

We first examined a small quarry where the titanic iron came down close to the road. The grey massive iron was mingled with streaks of brown mica and a green, somewhat asbestiforous-looking mineral, which may be hornblende or pyroxene.

Then we drove to the foot of the first manganiferous and iron hill and studied a typical outcrop, exposing about 20 feet thickness of the ores near the roadside.

The appearance was that of horrible, rough, scraggy, black and rusty material like clinkers freshly thrown out from a slag furnace. Streaks of brown mica occasionally ran in and out of this, together with patches and veinlets of white crystalline calcspar.

The deposit was full of rough stalactitic cavities. Underneath some 20 feet of this "cap rock" the dark manganese proper begins, whose bottom, confines, or limits have not been reached or determined. Much the same typical formation continues to the top of the hill some 500 or 600 feet. Mr. Lewis, who owns these remarkable hills, and who is an old and experienced iron master from Missouri, and one of the pioneers of the iron and steel industry in that state accompanied us over the hills.

Passing around the corner of the mountain where it is separated from the next hill by Del Dorita creek, we climbed up to an opening made about 50 feet above the stream. Here the open quarry showed a face of 20 feet of solid ore without any ascertained limits. This was of manganese, yellow with rust from oxidation since the quarry was opened. Removing this crust we find beneath it the massive dark manganese. Numerous little cavities occurred in it lined with botryoidal or grape-like manganese, which on fracture, showed a radiating crystalline structure. Some crystallized lime or calcspar is also associated with the ore.

Mr. Lewis stated that in this quarry there was about the right natural combination of iron, lime and manganese to make spiegel iron used in steel making. A certain per cent. of phosphorus occurs. There is about 45 per cent. pure manganese. The ore could be mined at a cost of 15 cents per ton. A few hundred yards further up the creek along the base of the mountain we again climbed to an opening about 200 feet above the base where another open cut into the hill, 40 feet long showed a vertical face of 25 feet of solid ore without any definite limit. This is of iron and manganese, the greater portion being of solid steel-grey manganese of cavernous crackly nature, full of small irregular cavities sometimes lined with crystalline calcspar. At intervals of 50 feet above this are two other cuts in the same manganese showing at a glance 250 feet thickness of exposed ore and this practically continues to the top of the mountain, 500 feet.

Crossing the Del Dorita creek we ascended the next iron mountain passing up over similar iron and manganese deposits as in the preceding hill.

At the top of the hill, forming its crest, is an outcrop of brown cap rock calcspar. Crossing this and descending a few feet on the opposite slope we found quarries showing solid manganese and iron mixed with a fair amount of calcspar which would act well in fluxing. Iron, manganese and calcspar on this hill seem to lie in widely parallel zones. Mr. Lewis observed that of over 400,000 tons of manganese used in the United States, only 6,000 are produced in this country. The rest is imported from the Caucasian mountains and from the island of Cuba, where the leads are only four feet wide, and throughout the world all the manganese of commerce is from small leads in no way comparable with these vast deposits. The ore in these quarries, Mr. Lewis said, would net from 23 to 25 per cent. in manganese and 12 per cent. iron and 12 to 14 per cent. lime, another good combination for spiegel.

The lower part of this hill for some 200 feet to the base shows outcrops of calcspar standing up in little pinnacles mingled with deposits of iron and manganese.

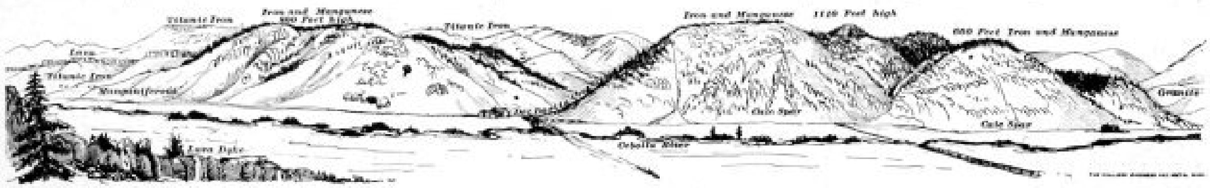
A deposit of brown jasper about 50 feet thick caps the top of this hill over an acre or so. South of this jasper is another remarkable body of ore shown in a cut which we called the "mountain rat quarry," as a colony of rats had made a nest in a crevice in the shaft. Here is an open cut showing a face of 20 feet of cap rock calcspar and iron mixed and below this a shaft 20 feet deep and 8 by 4 feet wide, all in solid grey iron, showing neither bottom nor lateral limits, in fact 40 feet of ore running 55 per cent. iron, the rest being silica and calcspar. Above the mine the outcrop of the cap rock on which they went down is seen. It looks like a brown sandstone traversed by thin seams of white calcspar and patches of iron and mica. Wherever this cap rock of calcspar vein outcrops, which it does very generally over the mountain, a heavy body of iron is sure to be found below it. This quarry was within 200 feet of the top of the hill and about 600 from the base. The maximum height of this hill above its base is 1,110 feet. Along the saddle joining this hill to the next, cap rock and prospect holes, all on solid manganese, occur for quite a distance.

These hills seem to have a sort of natural division of the ores. The eastern slope is one third manganese, the western two-thirds is of iron. Phosphorus in these openings on manganese, Mr. Lewis said, was not chemically combined with the ore but rather contained in the gangue the calcsparite and could be removed by reducing agencies.

Quarries also occur on the south slope of the end or last hill looking down into New Gulch, principally in unlimited bodies of remarkably pure iron, averaging, Mr. Lewis said, 60 per cent. iron. The lower portion of this hill shows the peculiar fringe of minarets and pinnacles of calcspar or travertine we have before alluded to.

ORIGIN AND HISTORY OF THE IRON AND MANGANESE MOUNTAINS.

The geological origin and history of these vast deposits of iron, manganese and calcspar we think is as follows:



THE CEBOLLA IRON AND MANGANESE MOUNTAINS, GUNNISON COUNTY, COLO.

In the first place we must remove a popular fallacy as to the supposed molten origin of iron deposits in general. These are not the direct results of igneous action or molten eruption. The ores are not the product of fire heat; they are not nor ever were in a molten condition like lava. They are the products of water and that in a heated state, in other words, hot mineral springs not unlike, perhaps, those still represented in miniature at the Cebolla resort, which are daily depositing both iron and manganese and calcspar, the same components as these great hills.

Though not the direct result of igneous eruption, the hills may have an indirect relation to such eruptive agencies. We have observed the prevalence of eruptive rhyolite (a lava closely allied to trachyte) in flows and dykes adjacent to the iron and manganese hills terminating at those hills.

Hot spring or solfataric or geyser action, together with a great variety of hot or cold mineral springs, are the natural and common accompaniments of the dying efforts of volcanic activity. It was such solfataric action that decomposed and leached out and redeposited the ores of Cripple Creek after the eruptions of andesite and phonolite had ceased and in fact most of our fissure veins and ore deposits have been formed in this way by solfataric or hot spring action.

AN INSTANCE OF ORE DEPOSIT BY GEYSER.

We had a remarkable instance of this on our trip through this same region not many miles distant, where the ore deposits of a mine called the Mammoth Chimney have evidently been deposited, in the form of opal and chalcedony rich in gold, along a line of fissure occupied by an ancient hot spring or geyser. One of the principal effects of the hot water and steam emanating from these hot springs is the decomposition and leaching out of soluble minerals and metals contained in the enclosing rocks from great depths even to near the surface. On reaching the surface the waters, laden with the solutions they have acquired in their upward course, deposit or precipitate it in solid oxidized form around their orifice. These deposits may be, as in the case of the Mammoth Chimney, silica, in the form of opal or chalcedony, but more commonly calcspar with iron and manganese. Hence the rusty mounds of calcspar built often to considerable height around the orifices of geysers and hot springs, as in the Yellowstone park, at Steamboat springs, Nevada, and even in a small way at the adjacent Cebolla hot springs.

What, then, these comparatively little hot springs are doing daily on a small scale where igneous activity has long ceased or become dormant, that, we conceive, on a vast scale and for a long period of time was carried on in the area where the iron, manganese and calcspar mountains now stand, when igneous forces were more energetic or had but a short time become latent.

It may seem an extravagant comparison between the little iron and calcspar mounds of modern living hot springs and the great mountains 1,000 feet high and 3 miles long; but allow vast periods of time, great igneous activity and powerful supply of hot mineral water, and we have a result by no means unparalleled in general geologic history.

We can fully endorse, from our own observations, Mr. Lewis' modest description of this great and unique property. He says:

"There are two hills or mountains of manganese and iron 800 and 1,000 feet high, their bases covering over 800 acres. From base to apex there are cuts, tunnels and shafts in solid ore, some of these more than forty feet in solid mineral, and in no place has the bottom or limit of the ore been reached. These openings are made at various distances for more than a mile in length by half a mile in width. So far as our experience goes, over this vast area it makes no difference where a hole is sunk, it goes into solid iron or manganese. It is generally found within a few inches of the surface, and in no case has it been necessary to go to a greater depth than 5 feet. Mining it could be open "quarry work," done at the minimum of cost. About one-third the area is manganese to itself entirely, or overlaying the iron to the depth of several hundred feet. On one hill, at its base, the manganese is opened up in mass between there and the summit. There are three large and several other smaller openings, all in manganese. So far as can be judged by the prospecting done, everything indicates that these immense deposits are as near solid as ores are ever found. The celebrated Cornwall ore banks in Pennsylvania are described as comprising three hills, 400, 200 and 160 feet high, covering an area of 105 acres, averaging 50 per cent. metallic iron. The area at Cebolla is 10 times that given of Cornwall, and averages 55 per cent. against Cornwall's 50, and besides, at Cebolla are the immense bodies of manganese ores, probably of greater value than the iron.

"The analyses show that the constituent elements in the ores average as follows:

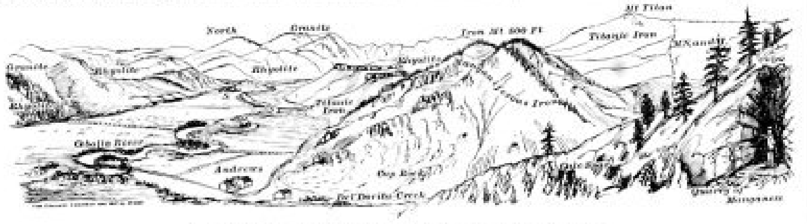
Silica	3.15
Alumina	1.61
Lime	8.60
M. N. oxide	1.36
Iron protoxide	8.46
Iron peroxide	67.04
Sulphur	trace
Titanic acid	trace
Metallic iron	54.91
Phosphorus	1.53

"The last ranges from 0.02 to 2.43. Owing to the vast area these ores can be so mined as to give any per cent. of phosphorus desired."

As to the rocks that may at depth have supplied these elements. The two prevailing rocks visible at the surface near the deposits are rhyolite and granite. Both could supply the silica, alumina and lime.

The iron might come from the iron bearing minerals of the granite, or it is barely possible that sedimentary rocks limestones, etc., shown in other parts of Gunnison county but not visible here locally at the surface, might have contributed their quota.

These valuable deposits are within 20 miles of Gunnison City and the Rio Grande railway and there would be little difficulty in constructing a railroad up the Cebolla creek to these properties.



Iron Mountain, Looking North. S, Cebolla Hot Springs Resort.

Quarry in Manganese Showing 25 Ft. Face Thickness of Solid Manganese.

HOT SPRING DEPOSITS.

How Vegetable Growths Assist Their Formation and Deposition.

Written for The Colliery Engineer and Metal Miner by Prof. Arthur Lakes.

In speaking of the origin of veins and ore deposits we have had frequent occasion in past articles to call attention to hot springs and their deposits, as at Cripple Creek, Steamboat Springs, and the Vulcan and Mammoth mine at Gunnison, and to the great importance of solfataric action.

In the Steamboat Springs region of Colorado, we described sometime since, the mounds and saucers of travertine or calcspar built up around the springs, and tried to describe the exquisite colors in some of the spring basins—delicate rose color, pink, yellow and dark green. The dark green we readily attributed to the gelatinous algæ or water weed, which comes up abundantly and floats on the surface above the orifices of springs even where their waters are over 100 degrees Fahrenheit. The other colors we thought might be from mineral tints, but according to Mr. Walter H. Weed (U. S. Geological Surveyor) all these tints are due to different kinds of algæ, often very minute. The same exquisite tints are seen in the geyser and hot spring basins of the Yellowstone Park, and are all due to the same cause. Nay, more than this, Mr. Weed shows us that the enormous bodies of travertine themselves, often covering many square acres and even square miles, are due to the precipitation of lime and silica through the medium of those singular plant forms. He says: "The travertine deposits of the mammoth hot springs in the Yellowstone Park, form one of the most interesting features of the region, covering two square miles and attaining a thickness in places of 250 feet. The deposits have few equals in size, while the beauty of the terraced basins, the brightly tinted slopes covered by the steaming waters, and the varied views presented cannot fail to impress every observer. In wandering about the springs one is sure to notice the brightly tinted basins surrounding the vents, with the red or orange colors of the slopes overflowed by the hot waters. These colors are due not to mineral matter but to the presence of algæ growing in the hot waters, and frequently so covered by carbonate of lime as to be scarcely recognizable. These plants take a most important part in the formation of the travertine deposits, and, in fact, it is their presence which has caused the great beauty of the deposits. The varied tints are due to a different color of the algæ at varying temperatures, examples of which are seen in the beautiful mosaic of basins about the vents of the Blue Springs, on the main terrace. The fact that these deposits of travertine are mainly due to plant life has been fully proven by a careful study of the old deposit and of those now forming. The plant life is the chief factor in the production of the many varieties of calc-sinter found about the springs. In the case of the fiberous tufa, forming the fan shaped masses found about many of the vents, an examination with the microscope shows that the fibres are simply encrusted algæ threads. The rippled surface of the algæ deposits covered by the overflow of the larger springs, shows a furry covering of orange colored algæ, the upright threads extending down into the mass. The algæ filaments serve as a nucleus for encrustation, besides absorbing carbon dioxide and thus causing the separation of lime carbonate. The masses of gelatinous algæ, often several inches thick, and forming mat-like coverings in the sluggish overflow channels, show the action of plant life most clearly. The successive layers of membrane-like material carry minute little crystals and stellate accretions scattered about in the plant tissue. These grow into small pellets that uniting together produce firm layers. Thin laminæ of carbonate of lime also form between the membranes and a compact deposit of travertine results from a combination of the two.

"The hot springs and geysers of the Yellowstone are surrounded by large areas of siliceous sinter (opaline quartz) that often entirely cover the floor of the geyser basin. About the spouting vents this material has been built up into mounds and cones of unique forms and great beauty. The more quiet pools have built up more or less regular mounds of white sinter which are in places as much as 20 feet in height above the surrounding level. Besides these deposits the alkaline waters of the geyser regions have left deposits of silica wherever they have flowed, and many square miles within the park are covered by white and glistening deposits of this material. Deposits of silica are formed about the geysers and margins of springs by evaporation, producing a true geyserite, and this silica is separated by plant life by the algæ that abound in the hot waters of the region, and by this agency by far the largest part of the sinter deposits of the region have been formed.

"This algous vegetation with its varied tints of pink, yellow, orange, red, brown and green, adorns the slopes of the geyser cones, flushes the white silica of the little basins with its tints and marks the waterways with its brilliant colors. It is ever present where the temperature does not exceed 185° F., often lining the great bowls of the cooler springs with leathery sheets of brown and green. Where a constant overflow prevails the channel is filled by a vigorous growth in which an algæ mat is formed having the consistency of a firm jelly, and most beautifully colored. In whatever form it is found, and no matter how brilliantly tinted, this algous material, if removed from the water and dried in the hot sun of the regions, rapidly loses its color, shrinks in size and becomes an opaque white mass of silica, whose weight is not one per cent. of its former state. Chemical analysis shows this dried material to be silica and water:

$S_i O_2$	93.37
$H_2 O$	4.17
Organic matter	1.50

"The growing algæ form a jelly of hydrous silica; of this the algæ filaments are formed and the algæ slime is a hydrous silica binding the threads together." In the case of siliceous sinter formation, algæ growing in the waters choke up the channel and cause the main supply to be diverted. Basins are formed by the algous growth and in them pillars grow up from the bottom, often a foot in height. These increasing in number finally fill up the pool, and their tops reaching the surface coalesce and roof over the basin until the waters becoming choked seek other outlets. The gradual lessening of this supply of water causes the final death of the algæ. In the cool waters that fill the space between the pillars the hydrous silica begins to harden. Aided by the acids of the decomposing vegetable matter this process is quite rapid and more silica is separated from the cold water to form a coral-like coating, and finally the former soft algous jelly becomes a hard firm rock. Eventually diversions of the hot waters build up another growth upon the old one and thus the channel, swinging around from side to side, successively forms new basins, new growths and new deposits of silica.

"The importance of these plant growths in building up sinter deposits may be realized when it is stated that in the walls of the great Excelsior geyser a section of 15 feet in thickness is exposed of which over 12 feet is recognized as clearly of algous formation and the remainder of cemented fragments of weathered sinter. Sinter is formed by evaporation very slowly. At Firehole geyser basin one-twentieth of an inch a year is the maximum. Sinter, however, formed by plant life may attain a thickness of 8 inches a year.

"Diatom beds occur in the park in cool marshes supplied by hot spring waters. The resulting diatom earth, beds of which are sometimes 6 feet thick, contains glassy silica separated from the waters by decomposing vegetable matter."

The manner in which these minute hot water plants secrete and deposit lime and quartz and so in time build up mighty structures is as wonderful as that by which the tiny coral polyp secretes lime from the seawater and builds up the great coral reef. *

The Dodge System of Coal Storage Chosen by the Erie.

The Erie Railroad Co., after careful investigation and the consideration of a number of plans, have contracted with the Dodge Coal Storage Co., of Philadelphia, Pa., for a 150,000-ton storage plant at East Buffalo, N. Y. The coal will be stocked in nine divisions or piles, each of about 17,000 tons capacity. The plant will be constructed under the patents of the well known Dodge system, with the latest improvements, including a complete haulage system for handling the cars. The efficiency of the Dodge system is demonstrated by the fact that every railroad using it has contracted for a second plant after more or less extended experience with the first.

Hoisting and Conveying Machinery.

Messrs. S. Flory & Co., of the Bangor Foundry and Engine Works, Bangor, Pa., report a flourishing business in cableways and hoisting machinery from various parts of the continent. They are now at work on an elaborate new catalogue, which will shortly be ready for distribution. Messrs. Flory & Co. have added to their engines an improved friction clutch, which has proven to be an effective and highly appreciated appliance. It is so constructed that all parts are of standard size and repairs can be easily and quickly made.

HOISTING MACHINERY.

Description of a Proposed Modification of the Koepe System.

Written for THE COLLIERY ENGINEER AND METAL MINER by WM. M. MORRIS, Pueblo, Colo.

In your February issue, page 166, you publish an article on methods of mining in Butte, Mont., in which there is given a description of the hoisting appliances at the Anaconda mine, and of new hoisting machinery about to be erected, which is designated as of the most modern type.

I do not wish to be considered too severe a critic, but I desire to compare the proposed Anaconda system with what I consider the most modern type of hoisting machinery, and I therefore introduce sketches, Figs. 1, 2, 3, 4 and 5, to illustrate my ideas.

Figs. 1, 2 and 3 show an old system patented in Europe and used with success in England and on the continent. Figs. 2 and 3 show the system known as the Koepe system of haulage, deriving its name from its inventor. It consists of one rope for the two cages, with a tail or balance rope attached underneath the cage, working around a wheel in the sump, as shown at *A*, Fig. 2. By this system a smaller engine with one coil of rope around the drum and with a friction brake on one or both sides of the drum wheel can be used. Records show that the rope never slips on the drum. The balance rope is of the same weight as the hoisting rope, and an old worn-out rope answers, as it has nothing but its own weight to lift. It effects a saving in power in hoisting the weight of the rope and a perfect balance at all points in the shaft, as against a variation of weight during different portions of the hoist under conditions existing in the old system.

Fig. 4 shows a system of hoisting that was designed by me. I designed the cage in 1886 or 1887, and gave it to a miner from Litchfield, Ill., who patented it. My arrangement with him was that I was to get half of the proceeds, but I have never heard from him since. On a trip to Leavenworth, Kan., in 1890, I recommended this system to the Messrs. Braidwood, who had a shaft 735 feet deep and did not have power enough to hoist. I met a man last summer at Belleville, Ill., who told me that the Messrs. Braidwood had patented this idea.

I have added to my old plans the chutes shown at *C C C C*, Fig. 4, thus making one of the most complete and economical hoists in use. I claim that with two men, one on each cage, three tons per minute can be hoisted from a depth of 2,500 feet. Fig. 4 shows a sectional view of a metal mine, but it is obvious that the system can be used as well in a coal mine.

I claim by this system of hoisting a saving of the work of eleven men, as follows: Five men on top and two men at each of the four landings or levels, as shown on Fig. 4, less the two men on cages. Assuming that these men are paid $2.00 per day, makes a total saving of $22.00. Next comes the saving in mine cars. As an example, we will take the proposed system of hoisting at Anaconda mine with double deck cages, three cars on a deck, making for the two cages, six cars on a cage, twelve cars. Then assume six cars on top and six at each level, making a total of 42 mine cars saved by my system. The price of these cars at the lowest estimate is $20 each, making $840.

Now, I can substitute in place of the two men to ride the cages one man on top to open the cage doors, which can be done by a system of levers, but I prefer a sure thing as against uncertainties, and therefore suggest a ratchet and pinion, as shown in the upper part of Fig. 5. A man can give one turn of the crank wheel and raise both cage doors in a second. The coal or ore will then slide out quickly into both chutes on either side. The doors can be lowered as soon as the material slides out and the cage is ready to descend into the shaft.

The upper deck *A*, Fig. 5, is intended for men, tools, props or mules. The steel box *B*, below, can be made to hold from four to six tons, in accordance with the capacity of the mine. A hoist can be made in, say, 1½ minutes, the loading and unloading of the cages can easily be done in half a minute. This gives, with a six ton box, three tons per minute, or 180 tons per hour hoisting from a 2,400′ shaft. This requires a velocity of

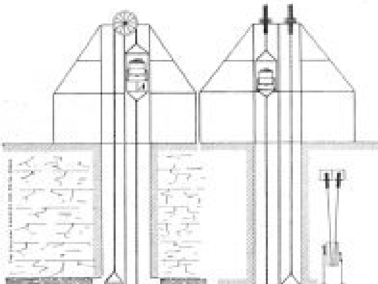


FIG. 1. FIG. 2. FIG. 3.

only 26⅔′ per second with a 10′ drum. I have had hoists which worked at a velocity of 35′ per second from a shaft only 350′ deep. Now, with a change in the arrangement of the men, say one man on top of the shaft and one man for each two levels, if they are opposite each other, in which case there should be a track around the shaft, so that coal or ore can be dropped into the chutes from either side, this man could attend to the dumping and signaling, as well as to the loading of the cages, and a total of three men is all that is required.

The cage with the steel box will not weigh any more than any other double deck cage, or at least will not be much more in weight.

To make my sketches clear, I would state that Fig. 1 is an old-fashioned balance pit used to hoist coal or ore when water is plenty and where the mineral can be elevated and the water run out at a lower level. A boiler iron tank *A A* is made to hold the weight of the load under the cage. The water is let into the tank from the top and let out at the bottom of the shaft; this is done while caging the cars. A powerful brake is placed on the pulley, or sheave wheel, which holds the cage at any point in the shaft, either with or without load. It must be understood that the water being emptied from the tank at the foot of the hoist must have an outlet some place to the surface. The chain underneath the cage is the same weight as the hoisting rope or chain. The Koepe system shown in Figs. 2 and 3 was no doubt taken from this idea. It is nearly the same as the system shown in Fig. 1, except that a rope is used under the cage with the wheel *A*, at the bottom of the shaft, to guide the rope and secure a perfect balance at any point in the shaft. Fig. 3 is the ground plan, showing the shaft, drum, brake wheels, pulleys and a pair of engines with one turn of the rope around the drum.

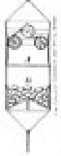


FIG. 4.

Fig. 4, which illustrates my plan, shows the engine, drum, hoisting tower and end view of the shaft with levels, dumping chutes and cars, also double deck cages. The upper deck *A* of the cage is for men only; the lower deck *B* is a steel boiler plate box, into which the coal or ore is dumped at each level by simply lifting the doors *C C C* with levers. The cage at the bottom is shown ready to load. The cage at the top is shown ready to unload into the chutes at each side by lifting the cage doors with the ratchet and pinion, the same as

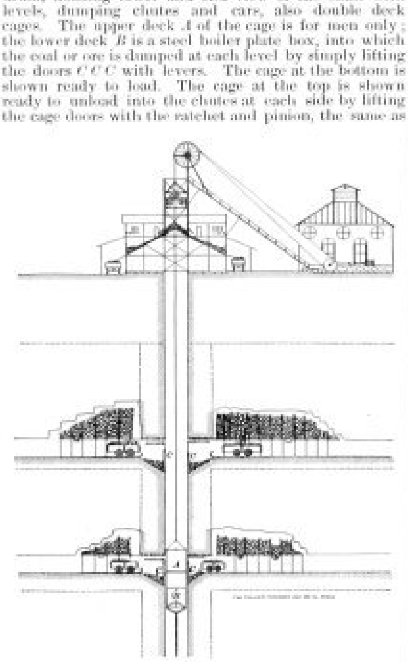


FIG. 5.

water gates are lifted. The bottom of the box pitches in both directions at the rate of seven inches to the foot. A man is required to ride on each cage to load and unload it.

Now, in regard to the comment on the proposed plant at Anaconda. In the first place, the expansion cylinders and Corliss valves in an engine running constantly are undoubtedly a great improvement over the old high-pressure engine, but in a hoisting engine that has so many stops and starts to make it is doubtful whether the same benefit can be secured. However, I do not want to be on record as opposing this plan until I have some definite information as to the results achieved, but the system of double deck cages and flat ropes is fifty years old and a nuisance. It requires too many men to do the decking, and there is too much time wasted in decking. Then, the great weight and cost of a flat rope and the quick destruction of the same by wear makes it very undesirable. A round, hammered or plough steel rope 1½″ in diameter whose safe load is 16 tons and breaking load 75 tons, with a weight per foot of 2½ pounds, is better than a flat rope ½″ x 8″ whose weight per foot will be about 6 pounds. The article from *The Mining World* says the two reels will wind up 5000′ of ½″ x 8″ cable. Allowing one reel 2,500′ and 100′ for pulley and reel, leaves 2,400′ of rope hanging in the shaft; this will weigh 2,400 × 6, or 14,400 lbs., equivalent to 7½ tons. This weight will have to be lifted in addition to the net load at each hoist. The 6 loaded cars weighing 6 tons, make a total of 13½ tons without the weight of the cars or cage, which are supposed to balance themselves. This weight will require an engine of 1,200 horse-power. By using the round rope, balanced as I suggest, a 600 horse-power engine would do, and by using the Morris cage system, the weight of 12 cars, say, 6 tons, plus the 7½ tons saved in weight of rope, makes 13½ tons, and if we add to this the weight of the round hoisting rope, 6,000 lbs., or 3 tons, and the weight of the tail or balance rope, making 6 tons, and subtract that from the 13½ tons, we have a saving in the weight hoisted of 7½ tons. Thus, by using my system and the Koepe system combined, there is a saving of 7½ tons at each hoist, and the same amount of material, 6 tons, is hoisted in each cage.

A 10′ drum making 80 revolutions in 1½ minutes makes a speed of 26⅔′ per second, which is not considered fast hoisting, and an engine, 24″ x 48″ cylinder, would furnish ample power with 80 pounds steam pressure. Let us see what this size engine with a 10′ drum will hoist from the bottom of the shaft. My rule is to multiply the area of the cylinder by the steam pressure and by the length of the crank in inches and divide it by the radius of the drum in inches, which will give the answer in pounds. Thus, the area of the cylinder is 452.39 x 24″, length of the crank in inches, x 80, the steam pressure, equals 888,588.80 lbs. Dividing this by the radius of the drum, 60″, gives the result of 14,810 lbs., nearly, or $7\frac{81}{200}$ tons. This is for one cylinder, the other to go for friction. The system is good for shafts running from 300 to 3,000 feet in depth.

A German Market for American Anthracite.

Mr. H. Barring, of Wilkes-Barre, Pa., who on the occasion of several visits to Europe, has given the question of the introduction of Pennsylvania anthracite into Germany considerable attention, writes us as follows:

"I enclose herewith a copy of a letter received from Brussels, which may be of some interest to you in view of the proposed attempt to compete with our anthracite coal in the European markets. Anything that you can do in furtherance of this scheme, in which I thoroughly believe, cannot fail to bear good fruits, if only as a matter of general satisfaction to you in having aided the settlement of the ever growing question of over production.

"In endeavoring to draw a conclusion from the within quotations of prices of German and Belgian anthracite, it should be borne in mind that Welsh anthracite, which is really the article against which we must expect to enter competition, costs from 6 to 7 marks, or $1.50 to $1.75 more at the ports than the much inferior anthracite mentioned above. Now, for instance, if German anthracite is worth at Amsterdam M. 24.80 a ton, which is equal to $6.20, Welsh coal would bring nearly $8 a ton, but even if it only brought $7 a ton, we could still beat them with our own coal even at full tide-water prices, and calculating on ocean freight rates at 11 shillings.

"The situation is not as favorable in some other places, as for instance, Cologne, where we meet German anthracite at 21 marks; this part of the country is in close proximity to the Westphalian mines. But we nevertheless can meet the competition of the Welsh coal there on equal terms. The same holds good in other places along the Rhine and the other large rivers of Germany."

The letter Mr. Barring refers to is from M. Hansen, of Brussels, Belgium, under date of April 27th, and is as follows:—

"Yours of the 19th inst. to hand. I shall forward to you small samples of Belgian and Westphalian anthracite. I have, however, no English (Welsh) anthracite at my disposal. Welsh is harder than Westphalian, and the latter harder than Belgian anthracite. Belgian is the quicker, German the slower burning coal, and for this reason the Belgian coal is preferred in Belgium, Holland, Southern Germany, Switzerland and France, the kitchen ranges in these countries requiring a free burning coal. English anthracite is the dearest of the three and its chief disadvantages are, irregular dimensions of nuts and not free enough from stones (slate).

"Anthracite must necessarily be *hard*, free from stones, and as much as possible not be smaller in diameter than 1½ inches, nor bigger than 2½ inches, and of course be smokeless.

"There is a good market for English anthracite in Holland, but its sale has diminished in Southern Germany. In Rotterdam, English anthracite has to be reshipped to go up the Rhine as far as Mannheim, from whence it goes to Southern Germany and Switzerland by rail. Westphalia and Belgium each produce annually about 300,000 tons of anthracite of the dimensions I named (about 25-50 mm.) and I am of the opinion that in a few years these countries will be unable to supply the ever increasing demand, and at suitable prices, large quantities of good foreign anthracite can be sold. The actual price is from M. 16 to M. 18 a ton on rail at the mine. Part of the Belgian mines are situated so as to load small vessels from 200 to 300 tons. Westphalian mines pay about M. 2.50 a ton for transportation to the Rhine." The medium price, 10 tons on rail is:

	German. Marks.	Belgian. Marks.
Brussels	224	190
Rotterdam	234	206
Amsterdam	248	231
Luxembourg	234	209
Cologne	210	217
Frankfort	257	266
Strasbourg	283	258
Freiburg	307	283
Ulm	315	308
Basel	309	284
Munich	350	348

Garlock Packing.

The Garlock Packing Co., of Palmyra, N. Y., report that the extensive additions to their factories are nearly completed. They are now manufacturing their water proof hydraulic and high pressure piston packings in both ring and spiral forms. They are receiving for both of these packings a constantly increasing trade and are crowded with orders for all kinds of their various packings, at both their Palmyra, N. Y., and Rome, Ga., factories. Mine managers who are not users of the Garlock packings should send in a small trial order which will most positively convince them of the superiority of Garlock packings over cheap inferior goods.

MINING SAFEGUARDS

TO INCREASE THE SECURITY OF MINERS.

Valuable Instructions From Bulletin No. 1, Colorado State Mining Bureau, by Harry A. Lee, Commissioner of Mines.

The act establishing the Bureau of Mines of Colorado provides that the officers of the department shall exercise practically the same functions as the mine inspectors in other states. In accordance with the spirit of the law, Commissioner Lee makes the following suggestions for ore mines in his Bulletin No. 1:

Explosives.—Explosives must be stored in a magazine provided for that purpose alone, and this magazine must be placed far enough from the working shaft, tunnel or incline to insure their remaining intact in case the whole stock exploded.

All explosives in excess of the amount required for a shift's work must be kept in the magazine. Under no conditions will the storage of powder in underground workings, where men are employed, be permitted. Each mine must have a suitable device for thawing powder and keeping it in condition for use. The water or steam bath is the only absolutely safe device. By a water bath is meant the surrounding of the vessel containing the powder with another vessel containing water which can be kept at the desired temperature. The thawing of powder with dry heat is unsafe. Dry heat under the most favorable conditions may exceed a temperature of safety. Miners should not be permitted to carry powder in their boot legs or elsewhere about their persons. A suitable place or places should be provided for preparing charges. At these points there should be a box or cupboard for caps and fuse. This should be securely fastened and so arranged that the caps cannot be jarred out or anything fall into the caps. A cap crimper should be attached to the side of the cupboard with a small chain.

Oils, Candles, Etc.—The storage of oils, candles and other inflammable substances demands the erection of a house for that purpose, and at a safe distance from the main buildings. They must not be stored with the explosives. Their removal for use, like the explosives, should be only in such quantities as are necessary to meet the requirements of a day.

Fire Protection.—All plants using steam—and especially small ones, where boiler, engine, blacksmith shop and shaft are all under one roof—must have a hose and hose connection to the injector or feed pump, and must keep the same ready for instant use. The line of hose should be sufficient to reach to the furthest point of the plant. As a rule the water supply at small plants is limited, and safety is largely dependent upon quick action. A few hand grenades hung about the plant in convenient places are great safeguards, and should be provided. Heating stoves placed in shaft houses should receive even more care in safety equipment than is common in dwelling houses.

Timbering.—Next to explosives, inadequate timbering causes more fatalities than anything about a mine. The general inclination is to use too frail and few timbers. No rule can be fixed for use of timber, the conditions must be met as they arise, and economy in timbering lies in doing well what is done. Strange as it may appear, taking districts as a whole, the best timbered mines are those most inaccessible and above the timber line, and the poorest timbered mines are those located in the woods. Temporary work which endangers life is criminal, and mine operators who supply their timbermen with material below the standard asked for assume very grave responsibilities.

Code of Signals.—1- Bell—Hoist (when not in motion).
1- Bell—Stop (when in motion).
1-1- Bell—Lower.
1-1-1-1 Bell—With care—Hoist (man on).
1-1-1-1-1 Bell—With care—Lower (man on).

Other signals to meet individual demands can be arranged, but the code in full must be plainly printed and placed in the engine room, at the collar of the shaft, and at each station or level, together with a notice and penalty for wrong or improper signals. Wrong or improper signals should be treated vigorously. An employe ascending upon one bell or descending upon two bells should be discharged. In mines working more than one level, signal gongs or speaking tubes should be placed from level to level. The danger of an employe signaling the engineer without first knowing the location of the cage or bucket is apparent. Where more than one level is being operated, special signals from lower to higher levels should be established; when established, the stopping of an up-going cage or bucket should be abolished. To illustrate this point: A. signals to hoist from the sixth to the second level; as the cage or bucket passes the fourth level B. stops it. The engineer is at a loss to understand; before executing one he has received another order. Let this be repeated several times and he becomes nervous. A rattled engineer is dangerous. It should be borne in mind that one bell does not mean "hoist until stopped," but "hoist to surface." Down-going buckets, or cages, are always "slowed down" at each level, and can be stopped with impunity; but on up-trips no one knows what signal is being obeyed, and therefore should not interfere.

The Bell Line.—The bell line should be so constructed that signals can be sounded clearly and easily from any station. This essential device is much neglected, and should receive more attention. A few iron sheave wheels or rollers, so placed that the line will stand clear of timbers, is often all that is required. At stations or levels where the line is used from both sides of the shaft, an attachment should be made so that reaching across the shaft for the line is unnecessary.

Hoisting and Lowering Men.—The hoisting or lowering of employes with a cage or bucket should be permitted or positively prohibited. If permitted, a notice must be posted near the head of the shaft, stating the maximum number who may use the cage or bucket at one time. This limit is not jeopardized when the men go "on shift," but, unless fixed, may be exceeded at the end of the day's work.

The handling of men with a bucket is very dangerous, and its use is discouraged by this department as much as possible. To issue an order stopping the use of the bucket for handling men would, at the present time, work a hardship in some districts upon both the miner and mine owner. But should the work of the bureau demonstrate the necessity, action will be taken and the practice stopped. It is to be hoped that the next legislature will enact a law compelling all new enterprises to use a cage in shafts two hundred feet deep and over. A strict compliance with the section of this bulletin entitled "Daily inspection," will be demanded of all mine operators hoisting and lowering employes.

Dump Guards.—At the end of each dump track, when a car is used, there should be a device to prevent the car going over, whether the load clears or not. It is generally supposed that a trammer can let go, but records show that while some do, the majority go over the dump with the car.

The Shaft Head.—The shaft head must be covered and so arranged that persons or foreign objects cannot fall in the shaft. When a cage is used, a bonnet which raises with the cage and falls back to place when the cage goes down, must be arranged. This bonnet or shaft cover need not be tight beyond what would stop a small animal from falling in, but the cage in turn must be supplied with a steel bonnet, oval in shape if solid, and if divided in the middle and hinged at the sides to admit sending down long timbers, the angles of the sides must not be less than forty-five degrees, nor the steel less than three-sixteenths of an inch thick. When a bucket and wooden doors are used, the shaft must be housed in and covered with doors which stand at an angle of not less than forty-five degrees pitch, hinged at the lower corners and opening upward or outward. These doors should not be less than four inches thick.

Stations.—All stations should have a passage-way around the shaft, so that crossing over the working department can be avoided. Where flat doors are used, a guard rail must be kept in place across the shaft and in front of the level, so that it will stop anyone walking or pushing a truck or car into the shaft. Across the track at some convenient distance an obstruction should be placed, so that cars or trucks cannot run by it and into the shaft, or trammers push cars by without removing the same.

Sinking Shafts.—Shafts equipped with mechanical appliances must be of at least two compartments, and the timbering must be kept well up with the work. When sinking, and work upon levels above are being prosecuted at the same time, especial care must be taken to protect men in the bottom of the shaft by placing close-fitting and strong doors in the working compartment, and by covering the ladder compartment with a plat, which will insure protection.

The Ladder Way.—All shafts over fifty feet in depth should be divided into at least two compartments, and one compartment set aside for a ladder way. The ladders should be sufficiently strong for the purpose demanded, and in vertical shafts should have landings at not more than twenty feet apart. The landings should be closely covered, except an opening large enough to permit the passage of a man, and the ladders should be so arranged that by no means could a person fall from one ladder through the opening to the next ladder. The ladders should be firmly fastened and kept in good repair. In incline shafts the landings should be put in as above described, but a straight ladder on the incline used.

The ladders in "upraises" or "winzes" from level to level should be likewise provided and kept in repair. Winzes or upraises are, after abandonment, very essential for ventilation, and, in case of accident, very essential as a means of escape. Just so long as they are necessary for the one cause and may be needed for the other, they should be kept in repair and ready for use if required.

Mill Holes and Winzes.—All winzes and mill holes running from level to level should be covered or surrounded with guard rails, so that persons walking along cannot step or fall in. Winzes, as a rule, are upon one side of the main drift and usually timbered a few sets above the drift level. Guard rails are easily placed about these. Mill holes, on the other hand, are often in the center of the drift. These must be securely covered with a door and kept covered.

Exits, Ventilation, Sanitary Condition.—As soon as practicable, all mines should have double or triple exits. Levels driven each way from the shaft must be connected by upraises or winzes, equipped with ladders and kept in good condition. These connections aid ventilation, and provide exits or means of escape in case of accident. Connections from first levels to the surface should also be made, unless underground connection is made with adjoining properties. Proper ventilation is of such vital importance to mine operators that it is well looked after, as a general rule. The sanitary condition about mines should receive careful attention. The use of abandoned stopes or drifts for closets should not be tolerated, and, where meals are eaten underground, the scattering of scraps and refuse matter about levels or stopes should not be permitted.

At the isolated mine boarding house, arrangements should be made for the disposal of slops and refuse matter. It should be the duty of the foreman in charge to look well to the sanitary condition of the bunk house and the cleanliness of his men. A large proportion of the miners are cleanly, but some are not; and a few filthy men in a bunk house soon infect the whole, or cause the cleanly men to quit rather than submit to the filthiness of their enforced associates. The condition of a bunk house is almost a sure index to the class of men employed. A cleanly and orderly condition predicts a thrifty, wide-awake and healthful crew, and *vice versa*.

The Indicator.—Upon all plants handling men, the engine should be supplied with a positive indicator. By a positive indicator is meant a device that is geared positively to the drum shaft and moves a target or indicator just as certain as the revolution of the drum raises or lowers the bucket or cage. Indicators arranged to move a target by the use of a string or wire cannot be depended upon, and are not as safe as marking the cable with a hemp wrapping or paint.

Mine Visiting.—The desire of persons, unaccustomed to mines and mining ways, to go underground should be discouraged. It is a novelty, an experience to relate to friends at home, but an experience in which the dangers are little appreciated, and of which it may be truly said, "ignorance is bliss." Were it within the province of this department to say who should and who should not enter mines, the line would be drawn sharply, and no one but employes or those having business would be admitted. Such a law would meet the hearty approval of all large mine operators, who appreciate the danger, trouble and expense to a company to be courteous; while the superintendents of smaller mines, whose better judgment is often overcome by a desire to please, would gladly take refuge and not assume the risks entailed.

Underground Surveys.—Each and every mine should keep an accurate plat of the underground workings, and have the same brought up to date at least once a month by competent engineers. No greater false economy can be practiced in mining than working upon the supposition that those in charge know just where drifts are. Where mines are adjacent, or working upon the same vein, and water is encountered, the necessity is apparent and imperative.

Boilers.—The bill creating the office of State Boiler Inspector makes mandatory provisions regarding the care of the boiler or boilers, and necessary reports to the inspector. It further provides severe penalties for failure to comply with requirements. Mine operators using steam or other pressure should familiarize themselves with this law and its mandates, and thereby insure the safety of all concerned.

The Mechanical Plant.—In the equipping of a mine with machinery, safety is too often sacrificed to false economy. When the expense of stops and repairs is taken into consideration, the very best machinery of a given capacity to be had, regardless of first cost, is the cheapest. It is well to bear in mind that competition in the mechanical line is so close that skilled labor, iron and steel, have a fixed market value, and that in accepting a plant of a given capacity from one firm, because its bid is $500 or $1,000 cheaper than another firm, the purchaser is simply buying that much less material or skill, and endangering the sucess of his enterprise.

The Mine Superintendent.—The duties and responsibilities of a mine superintendent cover a scope of requirements unequalled in any other professional calling. One of his most important duties is the formulating of a set of standing orders, the compliance with which will insure the safety of all under him. Fatal accidents can be too often traced to lack of mine discipline. Laws governing the employes about a mine should be as inexorable as in the regular army. Let the fact become established that failure to comply with regulations, however trivial, means loss of position, without recourse, and the safety of all concerned is almost assured.

The Mine Foreman.—The mine foreman is practically the working superintendent, and upon him devolves the detail of practical mining. The welfare of his employers and the safety of their employes is largely dependent upon his good judgment, and he must of necessity be a thorough miner, a good timberman, and a fair mechanic.

The Engineer.—Too much care cannot be exercised in the choice of this officer. His responsibilities are grave, and his work more wearing upon the nerves than the muscles. His cargo travels an invisible track, and must be guided by hearing and feeling. Safety demands that his whole senses be on the alert and concentrated on his work. His surroundings should be comfortable in a room by himself, and under no circumstances should he be permitted to converse with visitors while his engine is in motion. A law should be enacted compelling all engineers to undergo an examination, grading them by certificate accorning to ability. Engineers upon mines who handle men should all carry first grade certificates.

Daily Inspection.—All properties using mechanical appliances should be thoroughly inspected and reported upon daily. Some one man should be detailed to perform this duty at a given hour, and make a written report. These reports should be filed and show that that proper precautions are being taken. His duties should commence with the engineer, who will report the condition of the boiler, engine, cable, fire apparatus, &c. Then commencing at sheave wheel, he should test all bolts and nuts on boxes and gallows frame, the cable fastenings, and all things connected with the cage, bucket, doors or bonnets. Descending the shaft slowly, he should examine the bell line, timbers, lining boards, stulls, skids, rollers, guard rails at stations, doors, &c. He should also ascertain the amount of powder and the condition of the warmers. Ascending the shaft by ladders the same care as to detail should be exercised. Also the condition of winzes, upraises and ladder-ways, kept open for ventilation and exit in case of accident, should be examined.

The observance of this provision will prevent accidents and prove economical. It does not debar those in charge from "keeping their eyes open," but they are less apt to see danger than one whose especial duty it is and whose position is dependent upon not overlooking it. This inspection can be made in comparatively short time and at a time not to discommode the working of the mine.

In conclusion Mr. Lee says: To those who may feel the above recommendations to exacting, I desire to say there is nothing advised which is not in constant practice upon the older and best managed mines in the state. Because a mine is not paying is no excuse for jeopardizing human life by makeshift or temporary safety appliances. The common rule and the source of most all accidents is the desire to first "strike it rich and then make safe." The desire and duty of this department is to reverse the rule so it will read: "First make safe and then strike it rich."

ECONOMIES IN MINING

BY THE USE OF MECHANICAL APPLIANCES.

The Advantages Gained by Their Adoption, With Statements of Their Economy and the Conditions Suited to the Different Kinds.

By Cyrus Robinson, M. E., Columbus, Ohio. (Transactions Am. Inst. Min. Engineers.)

It has long since ceased to be necessary to urge coal operators and mining engineers to adopt power machinery in connection with some or all branches of their operations in mining, either at the face of the coal, in the entries, or at the tipple. The use of such machinery has become an accepted fact, and instead of having to consider whether we shall adopt power machinery or not, we simply accept it and consider what kind of machinery is best adapted for our requirements. And it will be the object of the writer to outline in this paper briefly, what points and methods are best to follow in considering any change of system or operation, in and about the mines, for the purpose of effecting the greatest economy.

First it is necessary to find out whether it is possible to effect an economy by making a change in the particular branch of operation to be considered. We will take first the haulage.

Assuming that we have decided an economy can be effected by installing a system of power haulage, the next point to be considered is the system best adapted to our conditions.

It is generally agreed and accepted by engineers that where the grades exceed 3 per cent. against the loads, traction haulage is not as efficient as rope haulage; therefore, where such conditions exist, we can eliminate all forms of traction haulage and simply consider rope haulage. As this in itself is a subject worthy of a separate paper, I will not stop to discuss it. If the grades are below 3 per cent. I believe that the best system to adopt is traction haulage. The next point to be considered would be the presence of gas and the nature of the coal dust in the mine. If there is explosive gas, even in small quantities, to be found in the pockets of the roof or crevices, it would not be safe to install electric or steam haulage and we are brought again to consider rope haulage or compressed air locomotives. If there is plenty of room in the entries and the curves are of large radii, a very efficient compressed air system can be installed, especially where there is any pumping to be done and where the coal is adapted to be worked by machines, but where the entries are low and crooked and the curves sharp, I do not think that, as the present compressed air locomotive is designed and built, it would prove successful. This narrows us down to some form of a rope plant or continuing with mules.

If the mine is free from gas and the grades against the load are below 3 per cent., I believe that no better system of haulage can be found than the electric system with traction locomotives, using the overhead trolley wire and a track return. During the past eight years between fifty and sixty of these plants have been installed and in many instances they have taken the place of endless and tail rope systems. The principal advantages of the electric system are its flexibility and simplicity, and in the writer's experience he has found that wherever electricity has been adopted as a means for the transmission of power in the mine, its use has been gradually extended to all parts where power is required, every addition increasing the economy by decreasing the fixed charges on the balance of the operations. In plants where an electric system of haulage has been installed, I have noticed that by degrees the system has been extended for the purpose of running the fans, pumps, screens and coal cutting machines from the same plant. It is not necessary to give any figures on this, as the reduction of the cost of fixed charges, by this extension, is self-evident. With the electric system in general use for haulage, coal cutting, pumping, etc., the greatest total economy is effected, the only labor expense in the mine being the locomotive man and the trip runner. The expense on the outside, of the engineer and fireman in the power station, being divided up amongst a number of different operations, makes a very small charge against the haulage, whereas with the tail rope system we have to have a trip runner and coupler, and with the endless rope system the gripman and the trip runner on the inside, as well as an engineer and fireman on the outside, and as the power can be used for no other operation, the whole of the expense of the engineer and the major portion of the expense of the fireman is chargeable against the haulage.

The cost of extending electric haulage is very small compared with other systems. The trolley line with all the necessary fittings, bonding of the track, erecting, etc., can be extended 500 feet for $50. A rope could not be extended this distance for less than $200, and it would be necessary to shut down for a period while this change was being made, while with electric haulage the extension could be made while the plant was in operation.

Another great advantage the electric haulage has over the rope systems is the ability to go into any part of the mine, and if necessary the locomotive can do switching, delivering any car irrespective of its place on the trip on any branch off the entry.

Another economy peculiar to the electric locomotive is the light track that can be used. It is claimed by many that it is necessary to put down just as heavy a rail for an electric locomotive as for a steam or compressed air locomotive. This is not the case. A ten ton electric locomotive will run on a thirty pound rail with an ordinary road bed with a minimum of track repairs, whereas a steam locomotive of this same weight would very soon pound a track of this weight to pieces; the difference between the two locomotives is that the electric locomotive has a true rotary motion and that, if designed and built properly, the entire weight, except the wheels and axles, rests on good spiral springs, so entirely doing away with the hammering of the track. The steam locomotive necessarily has connecting rods and a rigid wheel base, a large portion of the weight also resting dead on the axles. The action of the connecting rod and this weight is to hammer the track at every joint; the action of the steam cylinders, set at 90° as they are, tends to vibrate the locomotive crosswise and so continually spread the track. For a ten ton steam or compress air locomotive it is necessary to use not less than forty pound track to ensure the same minimum repairs as with a ten ton electric locomotive on thirty pound track. The difference in the cost of the two road beds would more than be enough to buy the electric locomotive in the average plant.

In this connection I wish to cite the experience of the Red Run Coal Company of Ralston, Pa. This company has a very long outside haul of about two miles. Some three years ago they purchased a steam locomotive and commenced to run it on twenty pound rails. In about six months they changed this to twenty-five pounds; six months later they changed it to thirty pounds and even now it is necessary to keep one man constantly at work on this track. The writer's company* recently made a contract with them for installing an electric plant for operating locomotives, machines and fans in the mine, the locomotive to haul the coal to the outside where the steam locomotive would take it. As the weight of the rails in use in the mine was twenty pounds, the superintendent was very desirous of having a locomotive that would weigh not more than four and one-half tons. The writer was of the opinion that this would not be of sufficient capacity to do his work and therefore furnished him a six and one-half ton locomotive. In view of the experience that this company had had with the steam locomotive, it was a difficult matter to convince them that the twenty pound rail would be all right for the six and one-half ton locomotive; and it was only on our company's guarantee, that they would try it. Since that time we have been receiving letters advising us how well the locomotive is working and how superior it is to the steam, as well as how little trouble they are having with the track.

COAL CUTTING.

Probably the greatest single economy that can be effected in and about a coal operation is in the substitution of machinery for hand labor in under-cutting the coal. With the present mining rates in Pennsylvania, Ohio and West Virginia, it is possible to obtain a saving of from fifteen to eighteen cents per ton where the breast form of machine can be used, and from six to eight cents per ton where the pick or punching machine is used. In no other branch of operating a coal mine is it possible to accomplish so much as in this one, and consequently this branch is receiving, and will continue to receive, for some time, the major portion of the attention of coal operators and engineers.

In considering this question, it is not difficult to decide whether it will pay to install a plant or not, as there are practically no coal mines in this country where machines will not pay. In this district alone the writer's company has installed machines which, all working, have a united capacity of some twenty-five thousand tons per day, while in the state of Ohio this is doubled. Even in the very thin veins (30″) of Alabama, machines of this make are found to make a reduction of from eighteen to twenty-five cents per ton, while out in Missouri and the Indian Territory, where the price of labor is much higher, the saving obtained is much greater. During the past few years we have installed numbers of machines in England, France, Austria, India and Chili. Reports from them and duplicate orders speak for the economy effected.

The question of advisability of introducing machines is no problem; the main and practically the only points to be considered are: What form of machine and power are best adapted to the existing conditions at the particular mine? Every mine presents new conditions, and the meeting of same requires intelligent and careful consideration. I believe that the first and most important question should be: Is there any explosive gas in the mine? If there is, or even if there are only traces at intervals, I should strike out from further consideration the use of electricity for transmitting the power. It has been urged by the manufacturers of electric machinery that a motor that does not spark at the commutator, or one that does not have any commutator, cannot fire gas, and consequently they advise the use of electric machinery for operating the coal cutters in a gaseous mine. The danger of an explosion does not arise from sparking at the motor, for the average spark from a well designed motor will not fire gas or dust, as it is not of long enough duration. It has been proved by experiments that to ignite fire-damp it is necessary to decompose it into its component parts with evolution of hydrogen, which becomes ignited, and the heat from the flame so caused eventually raises the temperature of the fire-damp to the point of ignition. This temperature, as everyone knows, is very high, so that it is perfectly safe to state that there is no danger from the motor itself, consequently, for this work we may conclude that a commutatorless motor has no advantages. The dangers arise from ruptured cables and wires, semi-short circuits caused by falls of roof, etc. Such a condition of affairs generally forms an electric arc of intense heat, and as same is not apt to be discovered, we will say, for the period of thirty seconds, sufficient time has elapsed to allow of the action described above taking place, and where gas is explosive by direct contact with a lamp, as is the case in the coal veins in the Pittsburg district lying below the bed of the rivers, it would be suicidal to install an electric plant.

*The Jeffrey Mfg. Co., Columbus, Ohio.

If gas is present in a mine, we have left for consideration only the form of machine to be used, breast machine or punching machine. If the roof and coal are ordinarily good, it would not pay, in the writer's opinion, to consider any form of machine except the breast machine, where the system of mining is room and pillar, and locomotive longwall machine where the system followed is long walls. As this latter system is not followed in this district, we will not consider it further. My reasons for making the above broad statement in favor of using the breast machines under the conditions mentioned are as follows:

1st. The coal can be undercut for about eight cents per ton less than with any other form of machine.

2nd. The coal is in better condition after it is mined.

3rd. Not so much territory is required for the same output, and consequently there is reduction of fixed charges and dead work.

4th. Ease of obtaining labor to operate such machines.

5th. The ability to cut in the fire-clay next to the coal in the thin veins where it is desirous to save as much of the coal as possible.

6th. Larger yield of coal per acre and consequent increased value of the lease and property, etc.

Where the roof is very bad and it is necessary to post close to the face, the punching machine will do good work. Although I have seen numbers of mines where at first glance it would have seemed impossible to work the breast machine, due to bad roof, the introduction of them has proved to be a success, the roof and conditions being very materially improved by the systematic process of machine mining, reduction of territory opened, and rapidity of advancement of the face, same generally being undercut twice in twenty-four hours from five to seven feet deep.

Where the mine is free from gas and the roof ordinarily good, it does not require a very extended investigation to prove the advantage and economy of electricity over all other systems of power transmission for your coal mine. The following table giving the cost of wire and pipe installed, based on the present market price of material and labor, shows very conclusively the superiority and economy of the electric system of transmission as compared with the pneumatic:

Horse Power Delivered.	Distance in Feet.	System of Transmission.	Total Loss in the Line.	Cost of Line Installed.
100	5,000	Compressed air	10 per cent.	$2,150.00
100	5,000	Electric 250 v.	10 per cent.	837.50
100	5,000	Electric 550 v.	10 per cent.	280.00

Guided by the above figures the inclination would be to decide in favor of the electric five hundred and fifty volt transmission and if the vein of coal had an average thickness of not less than five feet, the decision would be correct. In thinner veins, unless the distance from the power station to the point where the power is to be used exceeded ten thousand feet, I would not recommend the use of a current of a higher voltage than two hundred and fifty; if five hundred and fifty volts were used in a vein of this thickness it would be advisable to insulate the wires, and if this were done properly the cost of five thousand feet would be about the same as two hundred and fifty volts, so that nothing would be gained. Contact with a wire carrying a current of five hundred volts pressure is not productive of bad results if the person's system is in normal condition, but if he has a heart or nervous trouble it is apt to render him insensible and in some cases the contact would be fatal. The same proportionate conditions would obtain with a current at two hundred and fifty volts, so that we may say that the only safe thing to do is to keep men with such troubles away from electric currents. In veins exceeding five feet thick the writer's company has installed quite a number of plants using the high voltage system. The most notable among these being,

Youghiogheny River Coal Co., Scott Haven, Pa., No. 1 mine, 5 machines.

Youghiogheny River Coal Co., Scott Haven, Pa., No. 2 mine, 6 machines.

Knob Coal Co., Brownsville, Pa., 5 machines.

Crozer Coal & Coke Co, Elkhorn, W. Va., 5 machines.

Upland Coal & Coke Co., Upland, W. Va., 5 machines.

No trouble has been experienced at these plants from the use of this system and it is the writer's opinion that the majority of the plants installed in the future will employ the five hundred and fifty volt system.

If the first cost of the electric system is so much less, the extensions and maintenance give a still more favorable comparison, more particularly in the rooms from the cross entries to the face. When the electric system was first applied to coal cutting it was the custom to wire each room separately, running branch wires from the cross entry feeders in the same manner that the pipe branches are put in for compressed air transmission. The writer estimated that it would reduce the first cost to furnish an insulated concentric cable with each machine having a length equal to the length of the room and so do away with room wiring altogether. This system is now in general use and has been found very economical, not only doing away with the large investment in wire but also with the man required to keep up the room wiring.

It is not necessary for me to enlarge on the great advantages and economy of operation of the true and continuous rotary motion of the electric motor as compared with the reciprocating engines for transforming the power on the machine, and as I have already taken up more than my share of space and time, I will close this paper and hope at some other meeting to present another one, dealing with many other branches of this very important subject.

THE PROGRESS IN MINING

Abstracts From the Proceedings of the Mining Societies

And Journals of Europe and America, Illustrating the More Modern Developments in all Branches of the Mining Industry.

A THEORY IN MINE VENTILATION.—The following is copied from the *Colliery Guardian:*

In the case of bratticed workings in a coal mine, current theory teaches that the intake air-current should enter by the smaller side of the partition; for, as the current expands in traversing the mine workings, it is supposed to be evident that the larger volume should be assigned the larger section of passage. That is theory. But practice has demonstrated that it is sometimes better to ignore current theory, and give the larger volume the lesser passage. And thus we have to-day mining engineers who hold strictly to current theory and regard dubiously any supposed contradiction by experience, while we have many others who rely on the lessons of their own experience and reject such theory as may be contrary thereto. But while they thus reject the theory just referred to, they have no theory by which they can explain their own experience.

No doubt theories have been suggested to account for the heretical fact. The first time the writer had his faith in the orthodox theory shaken was seven years ago. The third edition of Mr. Wardle's work fell into his hands, and he was greatly struck by the instances quoted to show that the expanded volume oft-times chose the smaller passage. Mr. Wardle enunciated a theory to account for this, but this theory did not commend itself to the present writer. Some time afterward, the writer was sent to overlook a small sinking in Yorkshire. This shaft was divided by a canvas brattice, which divided the shaft circumference into two arcs, about 90° and 270° respectively. The ventilation was purely natural. On the morning of the writer's arrival, he found that owing to "stythe" (CO_2) the men were unable to get into the shaft. And he observed that they had slung a brazier of burning coal into the shaft from the jack roll. Of course, this brazier hung in the wide section of the shaft. The men's idea was that this brazier would act as a furnace and set up an upcast current on the wide side of the brattice. It was difficult to see what effective motive column they were likely to obtain from a brazier within three or four fathoms of the surface. However, the writer went to the narrow opening formed by the chord of brattice, and lighting a wisp of paper, held it over the aperture to see if there was any appreciable down draught. To his surprise he found an upward current actually proceeding from the supposed downcast. Some months later he had considerable trouble with a pair of winning headings giving off much gas. A brisk ventilation passed into these through air tubes. But at 24 or 25 yards the gas usually got the mastery, and holings at irregular points had to be made to cope with this state of things. It was originally intended that these holings should be made every 40 yards, but the pressure of the gas *in situ* obliged the management to make them much oftener. It was at last decided, as an experiment, to make the air-tubes the return instead of the intake. The result was that all the difficulty vanished, and thenceforth the headings went their proper distances without further trouble. Subsequently, the writer drove a stone drift. This drift was ventilated by boxes 15 inches square carrying the intake current. Coal was got at 110 yards, but the coal hewers had to drive a further distance of 120 yards to get a holing. Before this was accomplished the ventilation became so feeble that some alteration was deemed necessary. The boxes were then made the return, but in this case success refused to be wooed in any such manner. The result was absolute failure, and the writer got more puzzled than ever. He had seen the facts contradict the theory, and now here was fact apparently contradicting fact. The writer related these apparently contradictory experiences to a friend—a colliery manager—who remarked, "Well, it is difficult to form an opinion either way, and therefore we brattice our places on whichever side happens to be most convenient, but," he continued, "I have noticed that those places where the air goes in by the smaller passage invariably foul first, and this where all the places form a 'sheth' of bords ventilated continuously by the same current of air."

Now, such a statement concerning "a sheth of bords all ventilated by the same continuous current" is highly suggestive. The significant thing is that the place which fouls first, and that which fouls last have no point of difference in the matter of quantity, seeing that both are ventilated by the same current. Hence, when we ask this question as to which side should be the intake and which the return in a bratticed place, we may cancel this factor of quantity from our problem, for if it were only a matter of quantity, the "sheth" of bords all ventilated by the same current would alike foul, or all alike be cleansed, other things being equal. And it will be seen as we proceed that the question is solved, not so much by considerations that affect the quantity, as by those which affect the purification of the air at the face. It is not here positively and dogmatically asserted that quantity cannot positively be affected by the determination of which side of the brattice shall be the intake. The writer merely affirms that he cannot see what fluctuation in volume can result from a mere reversal of the current. The various resistances to the circulation of a given volume through a bratticed drift would appear to be much the same whether the current enter by the narrow or by the wide side. In either case the resistances of both sides must be attacked in turn; and it is difficult to imagine how the order of attack can affect the volume in the sense of increasing or diminishing it. One thing is certain, this constant examination of the question, only with reference to quantity, has for long obscured the true theory of a very important phase of colliery ventilation, viz., the rapid removal of deleterious fumes and gases from the working faces. And it is time colliery managers and engineers recognized that there are other factors in an efficient ventilation than mere volume; while the ventilating pressure as shown by a water-gauge is no record of the subtle gains, losses, restitutions and differential influences of the pressure *en route.*

Let us then accompany the ventilating current into the bratticed place, and observe its phenomena. The place may be a coal heading, or a mine tunnel through siliceous rock. In this communication we will assume that the deleterious gases in the face are, either by reason of their molecular weight or their expansion by heat, lighter, bulk for bulk, than air. For distinction, we will call all these gases other than air, vapor. We know, then, that if two gases of different density be thrown together, and if in the immediate vicinity there be a region of lower pressure, both gases will forthwith begin to flow, or expand in that direction. But the velocity of the lighter gas will be greater than that of the denser fluid. A volume of smoke visibly ascends when there is no appreciable upward current of the air. The smoke from a cigar travels from the center of the room to the chimney with a greater velocity than the air amongst which it moves. It is immaterial whether the regions of differential pressure are separated by a vertical or by a horizontal distance, the lighter vapor will travel quicker to, and sooner arrive at, the region of lower pressure. Translating these remarks into the language of mechanics, we affirm that:—The force (or pressure) acting on a particle of the denser fluid is equal to the force acting on a particle of the lighter fluid. Therefore, the quantity of motion in each particle is the same.

But, the quantity of motion = the mass × the velocity. Hence if the mass be less, the velocity will be greater. From which we conclude that the gas of lower density will expand into the region of low pressure with greater velocity. In the light of this incontrovertible law, let us examine the two cases under review. Let us first take the case of a drift with a brattice consisting of air-tubes by way of which the current returns from the face. In this case the air has come into the face by the larger passage. Hence it has lost little of its pressure. And hence by bringing in the current by the large side, we get the greatest possible pressure on the face of the drift. Then at the end of the tubes (*i. e.*, the entrance to them) we get at once the desiderated region of pronouncedly lower pressure due to the velocity imparted to the current as it enters the narrow opening. Yet further, the air having leisurely entered by the wide passage, is in a state of steady rest in comparison with another state to be described presently. Here then, we have a set of simple phenomena remarkably easy to understand. The force acting on the vaporous impurities and the air itself is the same. It is the difference of pressure obtaining between the face and the entrance to the tubes. In obedience to this force the air and vapor make for the return tubes. But the vaporous particles, being lighter, are more easily affected by the force; velocity is more easily and rapidly impressed upon them, and they continually beat the heavier air particles as all race together for the region of lower pressure at the entrance to the tubular return. Owing to their lighter mass, the vaporous particles are, as it were, strained out of the air at the face. Thus the quantity of air passing into the drift is not in any wise increased in volume; it is simply purified with the greatest possible rapidity at the face.

Let us now take the opposite case where the tubes carry the intake current to the face. Here, the current, after having overcome the great frictional resistances of the small air tubes, rushes into the face at a high velocity. This work is accomplished at the expense of its pressure. Therefore, having spent our pressure in the tubes, we cannot put it on the face, and so get a tremendously reduced pressure just where we want it greatest. But some will say: Look at the kinetic energy of the current thus put on the face; surely that will be a great factor in sweeping out the impure vapors! But this is just where current theory blunders. The kinetic energy at this point is a positive marplot. For the air rushing from the tubes into the face finds the vapor at relative rest. It pierces the vapor, rebounds from the face, again cleaves its way through the vapor, and heads for the return by the large passage, leaving the vapor behind in the unequal contest. If both started from rest, or from comparative rest, the natural properties of the vapor would enable it to beat the air in the race for the region of low pressure, but the kinetic energy accumulated by the air in the tubes gives it a flying start of the vapor. The result is the we get quite as much air around the drift, but that we fail to obtain the same purifying effect at the face as when the current goes in by the wide side. We get the air in, but we do not get the vapor out. We lose our pressure on the face by spending it in the boxes, and we nullify the natural tendency of the vapor to first escape by endowing the air, its competitor, with an undesirable kinetic energy. But that is not all. Not only do we minimize our pressure at the face, but we raise our pressure at the entrance of the wide return to a maximum. And thus we obtain a difference of pressure at these points absolutely in the wrong direction. For when the air is discharged from the tubes into the face, it eddies and whirls about until its velocity becomes readjusted to the requirements of the wider passage of return. And when this readjustment is affected, what is the result? No one who is familiar with the phenomena of fluids will dispute that we have now to reckon with a restitution of pressure at the very entrance to the wide return. Hence there is no immediate region of lower pressure to which the vapor can escape. True, there is such a region in the tubes, but the vapor can hardly be expected to go out of the drift by way of the intake. And as for the wide return, the entrance is blocked by the greatest pressure of all.

Let no one imagine that the ventilation of the drift would be impossible while such a distribution of pressures obtained. For a power other than fluid pressure is at work here—the power of kinetic energy. The drift, considered as a whole, is ventilated by its superiority of the fluid pressure at the entrance to its intake; but the face of the drift, considered by itself, is ventilated by the kinetic energy of the air from the tubes. But while the air comes into the face charged with a kinetic energy that enables it ultimately to overcome the restored pressure at the entrance to the wide return, we must remember that the deleterious vapor in the face has received no such endowment. It is knocked aside and scattered about by the air; it is caught and imprisoned in the vortices of the aerial whirlpools, but the restitution of pressure at the entrance to the wide return forbids its egress until its diffusion with the air is throughly complete. No doubt the air particles do drive out many vapor particles by sheer concussion, but in the race for a return which is of larger section than the intake, the natural properties and environment of the vapor unite to handicap it most severely. We get rid of all these difficulties by making the smaller passage the return. The natural properties of the vapor then assist it to escape with expedition. The pressures are then distributed with the best possible effect. And the air coming slowly in by the wide side gains no undue advantage of the vapor in the matter of accumulated kinetic energy. But it must be noted that this theory rests on factors pertaining rather to distribution of pressure than to distribution of quantity, or volume. The writer does not affirm that by making the smaller section of a bratticed placed the return you will get an increased volume of air, but he affirms that by this method you will sooner purify and more effectively cleanse the atmosphere at the face of the drift.

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COKE, GAS AND AMMONIA.—The following is taken from *Kuhlow's German Trade Review:*

By-products of distillation.—As being of particular interest in connection with the subject of by-product coke manufacture, we give an abstract translation of the paper read by Dr. Knublauch at the last meeting of the German Association of Gas and Water Engineers held at Cologne.

The behavior of the carbon and hydrogen of coal on distillation is the chief point of interest in gas or coke manufacture. At the coke ovens, the aim is to obtain the greatest quantity of carbon as solid residue; in the gas works, it is to hold as much carbon as possible in combination with hydrogen—and especially in those combinations which form the best illuminating hydrocarbons. The choice of coal and the conditions of production—more particularly the temperature of distillation—are the most important factors in producing the best illuminating gas. It has been shown that benzol and a small quantity of toluol are chiefly responsible for the illuminating power of gas; but exposure to a somewhat higher temperature will partially destroy them, with formation of graphitic carbon and so-called diluents. But besides the constituents of coal which on its distillation yield gases suitable for producing light and heat, there are certain other constituents, occuring in considerable quantities, which claim attention. These are sulphur and nitrogen, of which the latter is the more important, since certain of its products have a very high market value. The nitrogenous products of distillation were regarded for some time as very troublesome, and even to-day in gas works are often considered of secondary importance, though costly ammonia recovery apparatus is attached to coke ovens. The importance of the nitrogen products from coal will be sufficient justification for the publication of the following results of experiments and observations, made during a number of years at the Cologne Gas Works, and subsequently in the author's laboratory:

Nitrogen in Coal.—The amount of nitrogen is very variable in different sorts of coal, and even in the same kind. There is from 1.3 to 1.6 per cent. in Westphalian coal. The proportion that is converted to valuable compounds is, however, very small; forming only from 0.2 to 0.25 of the weight of Westphalian coal. The enormous amount of coal distilled daily in gas works and coke ovens makes the total quantity of these easily obtained compounds very large indeed. The daily demand of a million tons of coal over the whole globe, corresponds to a yield of ammonium sulphate of about 10,000 tons daily, taking the nitrogen recovered as ammonia at 0.2 per cent. of the coal. The coal used at Cologne puts yearly into the gas retorts alone about 1,000 tons of nitrogen, of which 200 tons is recovered as ammonia and cyanogen; and these, reckoned as sulphate, may be valued at £12,500. It may appear remarkable that 10 years ago we knew nothing of the remainder of the nitrogen; and only quite recently the matter of its disposition has been solved, in the course of a determination of the proportion which is converted to cyanogen.

We have seen that no certain relation exists between the nitrogen content of coal and the yield of nitrogen products; but until recently it was deemed correct to calculate the one from the other. This ignorance had two causes. On the one hand, too little value was attached to chemistry in the gas industry (and this remains the case); and, also, until the nitrogen question was better understood, probably there was no gas works at which the products could be so separated as to enable any molecule of the coal distilled to be traced in any form in the products obtained. When this had been effected very well in Cologne, after the chemical bearings of the subject had been properly worked out, the nitrogen question again came to the front. The defects in wet purification and in the liquor works having been disposed of by chemical guidance, experiments showed that the ammonia completely extracted from the gas in the gas liquor yielded only 9.6 to 10 parts of sulphate per 1,000 parts of coal—corresponding to a percentage of nitrogen in the coal of nearly 0.2 only. Estimations of the nitrogen in the coal carried out at the same time, showed seven to eight times that quantity—corresponding to 70 to 80 parts of sulphate per 1,000 parts of coal. Attempts to convert more nitrogen into ammonia were so far successful; but, on the other hand, disadvantages accrued, and the new processes were put on one side. The most memorable were the addition of lime to the coal before distillation, and the passage of steam over the incandescent coal and coke.

What Becomes of Lost Nitrogen.—What becomes of the 86 to 88 per cent. of the nitrogen of the coal unaccounted for hitherto? A very small quantity occurs as cyanogen in the gas and nitrogen bases in the tar; and there are only the coke and the gas where the residue may possibly be found. Actually, analyses showed a great quantity of nitrogen in the coke. The nitrogen content of the coke may even be higher than that of the coal, especially when the volatile nitrogen is small in relation to the total volatile matter of the coal. Nitrogen is not, like sulphur, detrimental to the use of the coke; and estimations of it were not, therefore, carried out for the valuation of the coke. Without entering closely into the question, we gain the impression that, with a higher temperature in the retorts, the nitrogen will not remain in the coke. After estimating in addition the nitrogen in the tar and the nitrogen as cyanogen in the gas, no other nitrogen compounds are in the products; and the surplus nitrogen must be free in the gas.

Exact results are scarcely obtainable in large scale working, or only after long continued trials; and therefore a laboratory apparatus was devised for distilling the coal. By this it was found that the generally possible yield of ammonia could be determined for various coals, and variations made dependent only on the choice of the coal. The results of experiments proved: (1) That the nitrogen content of the coal and its distribution among the different products are not in any degree proportional. For example, the yield of ammonia may be much greater from a coal of low than from one of high nitrogen content. This statement is also true of the other nitrogen products. Thus, a sample of coal containing 1.176 per cent. of nitrogen yielded 0.1874 as ammonia, and one containing 1.555 per cent. yielded 0.1850 and one containing 1.479 per cent. yield 0.2086. (2) These variations are frequently very great with coal of different origin, and often small with same kind, though even then they are sometimes very considerable. Foster has investigated the question as far as English coals are concerned; and Schilling has made some experiments with various kinds. The yield of ammonia found is confirmed in the three series of observations. The yield for different kinds of coal in coke ovens working on a large scale has been also determined; and a series of coal distillations has been made in which the ammonia has been completely extracted from the gas and liquor. Though more recently introduced at the coke ovens, ammonia recovery is often better carried out there than in many gas works. A large number of distillations of many kinds of coal have been made by the author to ascertain the yield in the various products. The average yield of sulphate of ammonia for coal from 15 different sources is shown in the following table:

EXPERIMENTS ON THE DISTILLATION OF COAL.

Source of Coal.	Number of Tests Made.	Average Yield of Sulphate per 1,000 Parts of Coal. Parts.
Westphalia (a) gas coal	6	10.4
" (b) cannel (so called)	3	7.7
" (c) coke oven coal	9	11.0
Upper Silesia (a) gas coal	1	13.5
" " (b) coke oven coal	8	
Lower Silesia (a) gas coal	2	7.7
" " (b) coke oven coal	3	8.4
Saar	6	8.2
England, gas coal	3	16.4
Belgium	1	6.8
Moravia, coke oven coal	3	10.6
Russia	1	11.8
North America	10	9.4
South America	1	13.3
Italy, lignite-like coal	2	28.9
Bohemia	2	7.4
Scotland, cannel	2	7.9
Spain	1	2.3
Australia	2	1.9

In choosing coal for gas making, it is desirable to ascertain the yield of tar, ammonia, and sulphuretted hydrogen, as well as that of coke and gas. The difference in yield of ammonia varies in importance according to the current prices of ammonia compounds. The difference between 8 and 12 parts per 1,000 parts of coal, would mean, to a works like Cologne, the difference beetween 700 and 1,050 tons of sulphate per year—that is so say, about £4,000 value. It is also of considerable importance to know the yield of sulphuretted hydrogen from a coal, especially in cases where the purifiers have occasionally to be worked to their utmost capacity. This yield also is in no degree proportional to the amount of sulphur in the coal. It is easy to choose coal which shall not throw a great burden on the purifying plant.

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FIRE-DAMP, THE FORMENOPHONE AND THE INDICATING SAFETY LAMP.—From the *Colliery Guardian.* The members of the French Fire-damp Commission are carrying out a series of tests on the Hardy formenophone at the Paris Conservatoire des Arts et Metiers; and at a recent meeting of the Societe des Ingenieurs Civils de France, M. Molinos presiding, the inventor, M. Ernest Hardy, director of the Thivencelles et Fresnes-Midi Collieries, Nord, made a communication as to the application of sonorous vibrations for analyzing two gases of different density by means of his apparatus, incidentally remarking that the communication as to this apparatus lately made to the Societe de l'Industrie Minerale, without his knowledge, was very incomplete.

M. Hardy began by recalling the fact that, *cæteris paribus*, the sharpness of sound given by a sonorous tube depends on the density of the gas which causes it to vibrate, so that if two organ pipes, tuned in pure air, be made to sound through being blown with pure air by two distinct bellows, they will be in unison; but if one of them be blown by a mixture of pure air and a quantity, even insignificant, of an extraneous gas, such as formene or carbonic acid, the sound of that pipe will be modified, and the two pipes sounding together will produce a discord, the number of vibrations in a given space of time being proportional to the quantity of foreign gas mixed with the air.

In the apparatus that he had devised, one of the blowers is always fed with the same pure air enclosed in a tight chamber, while the other is supplied with the surrounding atmosphere, which is drawn through a scrubber containing a concentrated solution of potash, for freeing the gaseous mixture from any carbonic acid which it might contain. On leaving the blowers, and before entering the sonorous tubes, the two gases pass through a regulator which reduces them to the same temperature, after which they are both saturated with water vapor, so that all causes of error are eliminated, leaving no correction to be made. A microphone is inserted in each of the sonorous tubes; and an electric current traverses the two microphones in succession, and also a telephone receiver, which repeats, while accentuating them, either the pure sound of the sonorous pipes or the discord which they may produce.

For registering the quantity of extraneous gas in the air, two speaking tubes connect the sonorous tubes with a sound-board, closed by a membrane, which reproduces the vibrations of the two sonorous tubes. When the latter sound in unison the membrane vibrates regularly and with the same amplitude; but, when there is discord, the difference of amplitude is utilized for interrupting an electric circuit, which passes through a telegraph translator. A wide paper band is continually unrolled by clockwork, a movement of which makes contact every five minutes for the space of exactly 20 seconds; and the current of a battery, controlled by the translator, passes through this 20-second contact, and then through an electro-magnet, which becomes active at each beat that takes place during the twenty seconds of observation, and which causes a ratchet wheel to revolve to the extent of one tooth. The ratchet wheel communicates its motion to another wheel, the spindle of which carries a hand provided with an inked disc. The hand starts from zero at each observation; and its disc traces the arc of a circle on the paper band, making a point at each discord. When the 20-second contact terminates, the hand stops, and, a few seconds afterwards, disengaging gear actuated by the clockwork brings back the hand and its disc to zero, ready for a fresh observation.

According to the observations of the French Fire-damp Commission, the density of fire-damp may vary from 0.5802 to 0.966; and it must be acknowledged that the density of this gas may be affected by the presence, in a mine atmosphere, of carbonic acid and water vapor. It is the former of these two substances which, on account of its great density, viz., 1.529, will chiefly vitiate the results registered by the apparatus; and calculation shows that 1 per cent. of carbonic acid may counterbalance 1.2 per cent. of fire-damp in the mine, or, what comes to the same thing, that 6 per cent. of carbonic acid may mask as much as 7.2 per cent. of fire-damp. If it be borne in mind that fire-damp ignites when present in the proportion of 7 per cent., and explodes in that of 8 per cent., it will be seen that this proportion of 6 per cent. of carbonic acid—which, it is true, has been met with but rarely in fire-damp—may prevent detection in the mine of an inflammable mixture very near the explosive point.

The proportion of 2.72 per cent. of carbonic acid, which has sometimes been met with in return airways, would mask 3.26 per cent. of fire-damp, a proportion vastly higher than the 0.5 per cent. which is tolerated as a maximum by the regulations in some coalfields. Carbonic acid appears also to greatly affect the precision of the indications furnished by the safety lamp, which is ordinarily used in collieries for the detection of fire-damp; but it certainly does not so affect them in the same proportion.

The influence exerted by water vapor (density 0.622) on the indications of the formenophone would be exerted in the contrary direction, by diminishing the density of the air passing through the apparatus. Calculation shows that 1 per cent. of water vapor will produce the same effect in the formenophone as 0.85 per cent. of fire-damp. This amounts to saying that 2 per cent. of water vapor—a proportion which is met with in return airways, owing to the respiration of men and horses, the combustion of lamps and the sprinkling of dusty mines where dust explosions (*coups de poussiere*) are to be feared—would convey the impression that fire-damp is present to the extent of 1.7 per cent., while the atmosphere might be perfectly free from this gas. It is therefore indispensable to only use the formenophone with an absolutely pure gas; and such a gas fire-damp certainly is not.

Nor is the density of air impregnated with fire-damp modified merely by the presence of extraneous gases in the fire-damp; on the contrary, it is also modified by the influence exerted by the temperature, because, for the apparatus to work properly, the gaseous currents traversing the two sonorous tubes must have absolutely the same temperature.

Now it must not be expected that the outer air, introduced into a mine as a standard of comparison, will be of exactly the same temperature as the air impregnated with fire-damp, which air, especially when stagnant in roof cavities, takes from the rocks their temperature increasing with the depth; and here comes in the importantance of the regulator of temperature for obtaining isothermic conditions in the two gases that it is proposed to analyse by the acoustic method. Great care must, however, be taken to secure the thorough efficiency of this temperature regulator, which is traversed very rapidly by the two gases to be compared. Here again a difference of only 1 deg. Cent., in the temperature of the two currents, modifying their density, will correspond with 0.0075 of fire-damp; a difference of 10 degs. Cent. between the mine atmosphere and that on the surface taken as a standard of comparison, will correspond with 0.075 or 7.5 per cent. of fire-damp, leading to the supposition that the atmosphere is inflammable, while all the time its expansion only has given rise to such an indication.

Other methods for indicating the percentage of fire-damp in the atmosphere of colliery workings were then passed in review by M. Coriot, who remarked that the safety lamp, which is in the hands of every miner, gives very valuable and correct indications, so much so that a practiced observer is able, with the Mueseler lamp, to detect eight one-thousandth parts of fire-damp in a mine atmosphere. It has also become possible, he added, with the last form of Fumat lamp (which has, behind the flame, a reflector that may receive a graduated scale), to measure the elongation of the flame very correctly, and to obtain indications corresponding with a half division of the scale—that is to say, with four one-thousandth parts of fire-damp. These very slight contents, far slighter than that of 0.07, which corresponds with the ignition of fire-damp, are thus revealed by a portable appliance, in the hands of all the men, simple, strong and sufficiently correct. If, however, a still greater exactitude be required, recourse must be had to lamps with an alcohol flame, the slight brilliancy of which permits of the rings caused by combustion of the fire-damp to be seen more clearly; and the Chesneau grisoumetric lamp is now giving very precise indications of one to two thousandth parts of fire-damp in the air. The speaker considered that such minute proportions of fire-damp as these can hardly be arrived at by the formenophone, which depends for its use upon the sense of hearing.

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THE SPONTANEOUS IGNITION OF COAL.—The following interesting extract is taken from *Kuhlow's German Trade Review*, and it is interesting to notice that Professor Dr. Medem traces spontaneous ignition to the oxidation of iron pyrites, and as no coal is entirely free from this sulphide of iron, the cases the doctor brings under notice become all the more interesting.

Professor Dr. Medem, in the course of a treatise on the spontaneous combustion of hay and coal, gives the following account of the causes of this phenomenon and methods that have been proposed for its prevention and suppression.

The simplest form of spontaneous ignition is exhibited by dry spongy platinum, and is due to the absorption and condensation of oxygen in the pores of the metal. When exposed to a current of hydrogen gas, chemical combination immediately sets in, raising the temperature sufficiently to ignite the stream of hydrogen.

In the case of charcoal, a pyrophoric tendency is only manifested when some of the volatile hydrocarbons have been left behind in the distillation process and enter into combination with absorbed oxygen. If, however, such charcoal be freely exposed to air, the external portions speedily lose this property, owing to the pores becoming saturated with air, but it will regain its pyrophoric character if powdered so that the internal layers are enabled to absorb oxygen. As the process of chemical combination only goes on in the interior of a heap, the best way to arrest it is to spread the charcoal out, since attempts at ventilation by blowing or drawing air through the mass will only result in increasing the combustion. Every time the charcoal is broken up the danger of ignition will recur, down to the time it is ground to powder, but powdered charcoal once "killed" by exposure to air never regains its pyrophoric properties.

Hard coals, brown coals, and the like are subject to two dangers, explosion and ignition, each having a separate cause. Explosion is due to the liberation of fire-damp following on a decrease in atmospheric pressure, whereas ignition results from the oxidation of the iron pyrites contained in the coal, when exposed to the action of oxygen and moisture. The danger is the greater the finer the state of division of the coal, and coal stacked above ground is particularly liable. Attempts made to reduce the danger by ventilating the stacks have failed in this case also, on account of the increased amount of oxygen thereby introduced into the interior of the mass, and accordingly the coal is stacked as tightly as possible in order to exclude air. Strangely enough, the practice of ventilating the coal bunkers of ships has not been altogether abandoned, notwithstanding Liebig's impressive warning given as far back as 1866, and neglect in this particular has frequently led to lamentable fatalities. Since 1865 no less than ninety-seven coal-laden vessels have been destroyed, and the lives of some 2,000 seamen sacrificed through spontaneous ignition of the cargo.

Mining Machinery.

We are in receipt of a copy of the 1896 catalogue of the Nelsonville Foundry and Machine Co., of Nelsonville, Ohio, a first-class plant under the superintendency of Mr. L. D. Howard, a gentleman of many years' experience in the manufacture of mining and conveying machinery. The company announces through its advertisement in this journal its ability to furnish first-class mining machinery of latest design for hoisting, haulage, ventilation, cleaning, sizing, conveying, etc., etc. The catalogue just mentioned consists of 170 pages of illustrations and text descriptive of the products of the Nelsonville shops, together with a number of pages of useful tables, formulae and data. It should be in the office of every mine manager.

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DAVY LAMPS.

THAT the Davy lamp is an unsafe lamp for miners has been proven time and time again to the satisfaction of all intelligent mining engineers and superintendents. That, when first invented by Sir Humphrey Davy, the Davy lamp was far in advance of any other means of lighting gaseous mines, we cheerfully admit, and join with the mining fraternity generally in honoring the memory of the great inventor. That it was the foundation on which all subsequent lamps, including the best now on the market, were built, is a matter that cannot be disputed. But *why* miners will insist on using the most primitive lamp made and will ignore the discoveries and inventions of late years, is something we cannot understand.

The Davy lamp is not only behind the times, but is absolutely unsafe under the conditions existing in coal mines to-day. When it was invented the velocities of air currents were much below those of to-day, and a velocity of six feet per second was an exceptionally high one, if ever attained. Under such conditions the "Davy" was comparatively safe. Miners, to-day, who would protest most vigorously, and rightly, against a sluggish air current, demand Davy lamps and refuse to use better and safer types.

We have personal knowledge of instances where mine managers have tried to introduce a safer type of lamp, and have failed on account of the miners refusing to use any but the "Davy." The unreliability of the Davy lamp was very forcibly impressed on the writer on the first ultimo. On that day he was in State Mine Inspector Brennan's office at Shamokin, Pa., when a telegram was handed to the inspector announcing that five men had been burned by an explosion of gas at Buck Ridge colliery. The inspector immediately ordered out his carriage and invited the writer to accompany him to the colliery. On arrival there it was found that two of the five men were fatally injured, and the other three seriously.

Investigation showed that in a group of three breasts or chambers, worked on a pitch of 65 or 70 degrees, the inside breast, which was driven up only 23 feet above the first heading, or aircourse, was full of practically pure fire-damp. The two breasts outside had been swept clear of gas by a vigorous current of air, but the men working them were not allowed to begin work until the gas was dislodged from the inside breast. These men, rather than lose time, tendered their services to assist in changing the location of a hand fan and in putting up a couple of lengths of small box piping up the breast. Five men were in the heading at the inside rib or manway of the breast containing the gas. All of them had Davy lamps, and, as a good current of air was flowing through the heading and past the body of gas, they felt safe. The pushing of a length of pipe up the breast dislodged a small quantity of gas, which was naturally forced down to the heading, where it mixed with such a quantity of air as to make it inflammable. The men had their lamps swung from their belts and as they moved around they naturally swung so that the flame passed through the gauze and ignited the gas. There was a burst of flame which scorched them and set their dry clothing on fire, and the burning clothing caused the most serious injuries. The main body of gas in the breast was too pure to ignite. The gas that ignited did not explode, it merely flashed. An examination of the lamps used by the men showed that all were in perfect condition. Thus, we have undoubted evidence of a serious and fatal accident directly due to a Davy lamp passing the flame in an atmosphere charged with inflammable gas.

There are improved safety lamps on the market, which have been severely tested, both experimentally and practically, and which have demonstrated their perfect safety by automatic extinguishment under such conditions, and which will not pass the flame under any velocity existing in mines. These lamps are known to intelligent mining men. Most operators are willing to supply them if the miners will use them, as they desire to protect their employes and property. In most cases the continuance of the use of the Davy lamp is due to the prejudices of the miners, and the sooner the more intelligent miners convince their obstinate brethren of the foolishness of refusing to accept the better and safer lamps, the better it will be for them.

The bituminous miners of Pennsylvania do not use the Davy lamp. They united with the operators and inspectors in having their use condemned by law. In this they showed themselves in advance of the anthracite miners, and they profit by this advance in securing greater safety.

UTILIZING NATURAL FORCES IN MINING.

IN a paper read before the Engineering Association of the South, Mr. Tyler Calhoun describes how the forces of nature are utilized by the Tennessee Coal, Iron and Railroad Co., at the Thomas mines.

The output of the mines, from a three ft. seam which outcrops on the mountain side, is from 800 to 1,000 tons per day. The inside haulage is effected by mules, but from the mine mouth to the chutes the loaded cars are moved by gravity, and the empties are returned by the same means. The arrangements for dumping the cars and opening the end gates are also automatic. Nos. 1 and 2 mines are practically self-draining, by gravity. No. 3 and part of No. 2 mine are largely in a depression into which considerable water runs during wet seasons. There is a large sump arranged at the lowest point in this basin in which is accumulated the water from over fifty acres of worked out territory. This water is taken out through two siphons, each 1,200 ft. long, one of which is 2 in. in diameter, and the other 3 in. The summit over which the water is run is only about six feet above the ordinary level of the water in the sump, but it is 600 ft. distant from the sump.

Even in mining the coal, advantage is taken of natural forces. Mr. Calhoun states that the more intelligent miners will, when conditions are favorable, undermine their coal three or four feet and let it stand in that condition over night, when it is found that the pressure of the overlying strata has broken down the coal, or has loosened it so that it is easily wedged down, thus saving the miner about five cents per ton in getting the coal and ensuring a much smaller percentage of slack.

To get the coal from the chutes to the railroad, 1,035 feet lower in the valley, a self-acting incline is used, over which two cars, holding eleven tons of coal, are run in a trip. These cars are set on a slope so that their tops are level when on the average grade of the incline. They are hopper bottomed, and the bottoms each consist of two swinging doors held in place by chains wound on a two-inch rod extending through the car and controlled by a ratchet, like those used on an ordinary railroad drop-bottom car.

A description of the incline is as follows: Its steepest grade, at the top, is 46 per cent., falling to 14 per cent. at the bottom, the average throughout the whole incline being 22 per cent. Its horizontal length is 4,700 ft. The rope used is a patent locked steel rope, 1¼ in. in diameter, and 4,900 feet long. Its tensile strength is placed at 67 tons, and safe working load at 13.4 tons. It is worked at about 7 tons direct strain on the steepest part of the incline. The rope carriers are 8 in. cast iron rollers placed 40 ft. apart. The drums are 7 ft. in diameter, and the guide sheaves, leading the rope on and off the drums, are of the same diameter. The movement of the trips is controlled by a combination of levers and a powerful screw, by means of which one man can stop the machinery, from full speed, so quickly that the rope, which is wrapped around the drums three and one-half times, can be made to slip in the grooves. The drums are set vertically, and in line with the incline tracks; and the brake bands, one on each drum, have their bearings on two cast iron rims that are bolted to the top of the drums, the bolt holes being slotted to allow for expansion of the brake rim without injury to the drum.

The shafts of the drums are coupled with extension shafts, which extend about nine feet above the drums, at which elevation they carry two spur wheels; these gear with two pinions, on two other shafts known as the fan shafts, in the ratio of 31 to 7. The fan shafts are carried in cup bearings that rest on girders just above the drums; these shafts have also two other bearings, one just below the pinions and one at the top. Between the pinions and the tops of the shafts are the fans, eight feet in diameter, with four wooden blades each; these fans act as regulators of the speed of the incline machinery. The regulation is practically perfect, the runners simply letting off the brakes gradually at the start, until the resistance of the atmosphere on the fans balances with the motive power of the incline, after which the fans regulate the speed to a nicety, until it becomes necessary to put on brakes at the end of the trip.

The incline track is laid with 30 pound steel rails, to a guage of 4 feet. It is a three rail track, except at the center, where the trips pass on a double track, and at the lower end, where they run on a single track, through an automatic switch, which each descending trip throws open for the following ascending trip.

From the foot of the incline the loaded incline cars run out to the railroad chutes by gravity, and return empty by the same means.

The coal is screened in the chutes by gravitating over a series screen composed of four separate screens each five feet in length, with a drop of from two to six inches from each screen to the one below it. This turns the lumps over and shakes up the coal so as to ensure very thorough cleaning. The slope of the screens is adjustable by means of threaded rods by which they are suspended from the track stringers above. The screen bars used are of the diamond top pattern, which have been found to be very efficient. From the time of dumping until loaded in railroad cars or into charging cars for the coke ovens, the coal is moved only by gravity. The charging cars, loaded with slack, run by gravity to the coke ovens, and are hauled back, empty, by mules.

The railroad tracks in the yard below the chutes are also arranged so that after the locomotive places the cars on the storage tracks, they are handled under the chutes, through the yard and over the track scales entirely by gravity.

In concluding his paper, of which we publish only a synopsis, Mr. Calhoun says:

"Thus it may be perceived that gravitation plays no unimportant part in the handling of coal at Thomas mines. This accommodating force stands ready to do many other money saving jobs for us at this place, when sufficiently urged. The regulating fans at the drum house consume forty or fifty horse power, which could at least be made to ventilate the mines.

"The outflow of water from the three mines, at the dryest time we have had for several years, was twenty-five gallons per minute. A few days since, after several days' rain, the flow was 350 gallons per minute, and a regular flow of 100 gallons may be depended upon in all ordinary weather. A hundred gallons per minute, led down the mountain in a pipe alongside the incline to the ovens, would easily give fifteen effective horse-power, with which a washing machine or a haulage plant on the ovens could be operated.

"These suggested utilizations of force may be more or less chimerical, on account of practical difficulties, but they serve to show that, to an engineer at least, many interesting problems will present themselves in connection with mining work."

THE GAS ENGINE FOR MINING WORK.

THE gas or gasolene engine for mining work is a mechanism that, as a rule, is not appreciated by mine managers.

We do not believe that for general use or heavy service it will ever approach the steam engine in point of efficiency or economy. But there are many instances in mining operations where it can be used to decided advantage.

For instance, there may be a fan located on an outlet some distance from the main plant, and the question of conveying steam to the engine through pipes has been settled as impracticable. The erection of a steam plant near the fan may be impracticable or too expensive in first cost and maintenance, and either electricity or the gas engine must be adopted. Electricity may not be advisable for local reasons. Then the gas engine is the motor. It is self-contained, and can be safely run by any intelligent man. The entire ventilating plant can be isolated, and as the gas for propelling the piston is generated in the cylinder, one man can manage the plant.

Again, for temporary use in running a pump in dip workings that will not last long enough to warrant the introduction of compressed air or electric power, the gas engine is a success. In fact, wherever a comparatively small power is needed at isolated points, a portable gas engine is an excellent motor. There is no doubt that the mining industry, with its numerous instances where from five to twenty horse power is temporarily required at isolated points, will in the near future employ hundreds of gas engines, particularly if their cost can be brought down to figures that will enable them to compete with other motors. We understand that gas engines are now on the market at reasonable prices, and if this is the case, we predict a demand for them, at mines, which will grow in proportion to the efforts of the manufacturers in introducing them to the mine managers.

MINE VISITING.

THE visiting of the interior of mines by men and women, to gratify idle curiosity, is a practice that cannot be too harshly condemned. They learn nothing from such visits, interfere with the work, and frequently run into great danger through their ignorance and unfamiliarity with mines. All they gain by such visits is an unpleasant sensation if they descend a shaft, and what to them is a novel experience in "darkness made visible." They can get the same unpleasant sensation by riding on a fast elevator from the upper floor of a sky scraping building, and can see just as much by going into a damp dark cellar on a dark night with no other illuminant than a small candle. Both of these trips can be made safely and without ruining clothing. Mine visitors who are inspired merely with idle curiosity and a desire for a novel experience are a nuisance to mine managers, and are frequently a source of danger not only to themselves, but to the employes. In his bulletin on Mining Safeguards (published on another page) Mr. Harry A. Lee, Commissioner of Mines of Colorado, denounces the practice of mine visiting by persons unaccustomed to mines, and suggests the enactment of a law prohibiting all persons but employes and those having business in a mine from entering. This is a good suggestion, and is one that will meet the approval of mine managers generally. Such a law would not prohibit mining engineers and mine officials visiting mines, because they have business in them. The mining engineer or mine official who visits a mine learns something, and is able to note peculiarities in the seam or vein and strata, in the methods of timbering, mining, drainage, haulage, ventilation, etc., etc., which would be entirely unnoticed by the novelty seeking visitor. The visiting of mines by mining engineers and mine officials cannot be too highly commended, but the reverse is the case when non-mining people indulge in the practice.

Catalogues, Etc., Received.

The Boston Belting Co., 256 to 260 Devonshire St., Boston, Mass., has just issued a convenient and handsome catalogue of first class mechanical rubber goods. It is a model of convenience and typography.

The Jeffrey Mfg Co.'s new catalogue of coal mining machines and mine equipments has just been received. It is an artistic illustrated publication of such a high grade as will ensure its being appreciated and saved by those fortunate enough to secure a copy.

The Norwalk Iron Works Co.'s new publication descriptive of the well known Norwalk air and gas compressor is a handsome illustrated pamphlet, which, besides describing the products of the company, contains considerable matter on the use of compressed air that is of value to all mine officials.

"Lidgerwood Cableways" and "The Lidgerwood Rapid Unloader" are the titles of two interesting and convenient pamphlets published in the usual excellent style of the Lidgerwood Mfg. Co. They are well illustrated and very interesting.

The Knowles Steam Pump Works' new catalogue of electric power pumps illustrates and describes "up to date" pumping machinery and contains some valuable rules and tables for the use of mine managers.

"An Era in Boiler Performance" is the title of a new publication of the Stirling Co., of Chicago, Ill. It contains a report on an evaporative test on three Stirling boilers at the Waltham Bleachery and Dye Works, Waltham, Mass., made on April 7th, by Dean & Main and D. P. Jones, engineers.

The General Electric Co.'s new catalogue of electric haulage, power and mining machinery is the handsomest catalogue yet issued by that enterprising company. It is something more than a mere illustrated catalogue. It is in fact a bound volume of illustrated articles on electrical mining machinery reprinted from THE COLLIERY ENGINEER AND METAL MINER, and other periodicals, together with a large amount of other matter. Typographically it is very fine and is well worthy a careful reading and preservation.

"Manilla Rope for Transmission and Hoisting" is the title of an artistic and interesting publication issued by the C. W. Hunt Co. of 45 Broadway, N. Y. It is a unique publication and one that is of more than passing interest.

Taken all through the publications mentioned above are the finest of their kind ever received at our office during any one month.

BOOK REVIEW.

THE STORY OF A PIECE OF COAL, by Edward A. Martin, F. G. S. This is a small volume of 168 pages, bound in flexible cloth, and uniform with other books published by the Messrs. D. Appleton & Co., in the series known as "The Library of Useful Stories." It is on the whole a very meritorious production, and we heartily recommend it to students and others dsirous of knowing something more of coal than the fact that they pay retail dealers a high price for a short ton of it. The department on the Fauna and Flora of the coal measures is especially good for so small a work, and those portions on the composition of coal, and the safety lamp are well worth reading. The chapter on "The Coal Supplies of the World," makes the grievous error of stating that Pennsylvania anthracite is "in inexhaustible quantity." We wish it was. Again, in speaking of the bituminous seams, it is stated that "a remarkable seam of coal has given the town of Pittsburg its name." This should be reversed. Pittsburg was a town under its present name long before the coal seam was named, and it derived its name from the author's distinguished countryman, Wm. Pitt, and the Pittsburgh seam is indirectly named after him. Otherwise the chapter is very good, and judging from the preface the author is not responsible for these two errors, which do not affect the value of the book to any marked extent. It is a remarkably cheap book, being sold by the publishers for forty cents.

SLOVAK GRAMMAR. FOR ENGLISH-SPEAKING STUDENTS. By Charlton Dixon, Philipsburg, Pa. Paper cover, 134 pages. Price, $1.25.

This book is the production of a mine foreman who has recognized the necessity of a knowledge of the Slovak language. On his endeavoring to get books treating on the subject, he found that he could only get German works. Being a good German scholar, he purchased the best text-books on the subject in that language, and translated the necessary matter into English, compiling and arranging it in the most convenient manner. Besides, he added a considerable amount of information that came to him in the course of his researches, which tends to make the book complete. The book was published and endorsed by the publishers, *American-Slavonic Gazette*, the leading Slovak paper in America. It is for sale by the author.

TAXATION. We have received from Mr. Geo. A. Schilling, Secretary of the Bureau of Labor Statistics of Illinois, copies of the advance sheets of the introduction and supplemental chapter of the second edition of the Eighth Biennial Report. These sheets take up the question of the present mode of assessments, and show that great injustice is done, particularly in large cities, by unequal taxation by which progressive business men, manufacturers, etc., as well as small property holders are unjustly discriminated against. The pages sent us are very strong, and the reforms proposed therein are endorsed by many of Chicago's most responsible business men.

FIFTH ANNUAL REPORT OF THE BUREAU OF LABOR STATISTICS AND MINES OF THE STATE OF TENNESSEE, FOR THE YEAR 1895, issued by Mr. F. P. Clute, Commissioner of Labor and Inspector of Mines, is a very complete report when the difficulties under which Mr. Clute labors are taken into consideration. It would be a much more valuable statistical document if the laws of Tennessee compelled all mine operators to furnish the mine inspector with the same statistics as the Pennsylvania inspectors receive. These statistics are of a nature that we can see no reason for some of the operators withholding.

DEPARTMENT OF GEOLOGY AND NATURAL RESOURCES OF INDIANA. TWENTIETH ANNUAL REPORT, 1895. This report, issued by Mr. W. S. Blatchley, State Geologist, is mainly a geological report, to which are added the reports of the Inspectors of Mines, and the reports of the State Supervisors of Oil Inspection for the years 1894 and 1895, and a paper on The Crawfishes of Indiana, by W. P. Hay, zoologist. It is an octavo, cloth bound volume, of over 500 pages.

IOWA GEOLOGICAL SURVEY, VOL. V. ANNUAL REPORT FOR THE YEAR 1895. This is a handsome volume of over 400 quarto pages, issued by Prof. Samuel Calvin, A. M., Ph. D., State Geologist, and H. Foster Bain, Assistant State Geologist. It is profusely and well illustrated, and as a whole is one of a series of reports that will eventually prove of great value to the state of Iowa.

Resignation of Inspector J. E. Roderick.

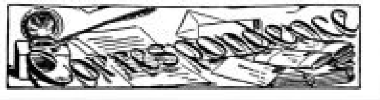
Mr. James E. Roderick of Hazleton, Pa., who was appointed mine inspector of the Fifth Anthracite District of Pennsylvania, last fall, has tendered his resignation, to take effect as soon as his successor can be selected. Mr. Roderick has resigned to accept the position of general superintendent of Mr. A. S. Van Wickle's collieries. His resignation at this time occasioned considerable surprise among his friends and acquaintances throughout the region, as this is the second time he has resigned as inspector to accept a position with private parties. Some years ago he resigned the inspectorship to accept the superintendency of Messrs. Linderman & Skeer's collieries, a position which he filled with signal success up till last fall. During his first incumbency of the inspectorship he made a record as one of the ablest and most conscientious of the state's officials. His ability as a mining man and his evident fitness for an important executive position soon attracted the attention of Messrs. Linderman & Skeer, who offered him a handsome increase over the salary the state paid him, and naturally he accepted the offer. Last fall, being aware that the Stockton collieries would probably be abandoned in a few months, he became a candidate for the position he had formerly resigned, and after a hard fought competive examination, he was recommended by the board of examiners for appointment. He had only served a few months of the term for which he was appointed, when Mr. Van Wickle, who is thoroughly familiar with his ability as a mine manager made him an offer which he wisely accepted. In this change, the state loses the services of an inspector who ranks in ability and general mining knowledge with any inspector of mines in the world, and Mr. Van Wickle secures one of the most competent mine managers in America.

Mr. Cyrus Robinson has resigned as engineer and manager of the mining department of the Jeffrey Mfg. Co., of Columbus, Ohio, and accepted the position of manager of the J. H. McEwen Co., with headquarters in New York city.

"A Few Facts and Figures of Interest to Mining Men" is the title of a leaflet issued by Charles Henry Davis, C. E., and T. W. Sprague, S. B., of 99 Cedar St., New York, who are consulting and supervising engineers making a specialty of the thorough examination of mines, mining properties and water powers and reporting on the best and most economical means for power transmission.

At the commencement exercises of the graduating class of '96 from the Steven's Institute of Technology, Hoboken, N. J., held June 18th, 1896, the degree of Doctor of Engineering was conferred by the faculty and trustees of Steven's Institute, upon Commodore George W. Melville, Engineer-in-Chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering, well illustrated in the world wide famed "White Squadron." Only once before in the twenty-five years' history of the Steven's Institute has the degree of Doctor of Engineering been conferred, and then upon Professor R. H. Thurston of Rhode Island, who formerly occupied the chair of Mechanical Engineer in Steven's Institute, and is now director of Sibley College, Cornell University.

The Garlock Packing Co., of Palmyra, N. Y. and Rome, Ga., have closed their office at Omaha, Neb. and opened a new office and salesroom at 1713 Wazee St., Denver, Col. Mr. Chas. B. Whitman, who is manager of the same, is well and favorably known by the trade and needs no introduction at our hands. The principal salesrooms of the company are at New York, Chicago, Philadelphia, Denver, St. Louis, Pittsburg and Boston. The Garlock Packing Co. are manufacturers of high grade packings for steam, water, gas, ammonia, etc. They manufacture water proof hydraulic packing, also high pressure packing which is especially adapted for high pressure work on locomotives, stationary and marine engines, and is designed to insure long service. Samples, catalogue and prices will be mailed on application. Address the nearest office.



This department is intended for the use of those who wish to express their views, or ask, or answer, questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The Editor is not responsible for views expressed in this Department.

☞ Correspondence should be in as simple language, and as free of technical terms and formulæ as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Ventilation.

Editor Colliery Engineer and Metal Miner:

SIR:—Please insert the following question in your valuable journal for answer by some of your correspondents:

The upcast and downcast of a mine are each 1′x12′x 400′, connected by three airways, each 6′x8′x750′. The water gauge is 1 inch. A fall occurs in one of the airways, closing off the current, the horse-power remaining constant. What change will take place in the quantity passing and in the water gauge? Yours, etc.,

STUDENT, Uniontown, Pa.

June 3d, 1896.

Methods of Working.

Editor Colliery Engineer and Metal Miner:

SIR:—I would be glad to hear from your correspondents as to the methods they would adopt for working a coal seam where conditions are as follows: Dip, about 20 to 25 degrees, regular, with no basin. Seam, cut off by fault 2,500 feet from outcrop. Coal, 6 feet thick. Character of coal, hard bituminous. Bottom bench of 12 inches, rather soft. Roof, 18 inches of draw slate, hard to hold; above that, a slippy shale, treacherous. Fire-damp given off. Considerable water. Product to enter domestic coal market, as it will not coke. Yours, etc.,

R. M. S. B., Henry Ellen, Ala.

May 20, 1896.

Explosives.

Editor Colliery Engineer and Metal Miner:

SIR:—I would be pleased if some of your able contributors would give me some reason why dynamite will not explode under the following circumstances: I have a well 5 inches in diameter and 139 feet deep, with 120 feet of water, at the bottom of which I tried to explode a stick of dynamite with a magnetic battery. The cap exploded, but the dynamite did not. I then took the dynamite out and tried it on the surface, and it ex-exploded all right. I then put two caps in one stick and put it in the well with the same result as before; the caps exploded, but the dynamite did not. I also tried it on the surface, and it exploded all right. I then fixed up a cartridge of powder, put it in the well without any dynamite, and it exploded all right. Now, the question is, why would the dynamite not explode, while the powder and caps would? W. A. GRAY,

May 23, 1896. Horse Creek, Ala.

A Question of Methods.

Editor Colliery Engineer and Metal Miner:

SIR:—In your May issue there are three solutions to the "tree" problem, a geometrical, an algebraic, and an arithmetical solution. The geometrical and algebraic solutions were perfectly clear, succinct and comprehensible, except that Mr. McTaggart might have simplified his solution by eliminating the unknown quantity y and proceeded with x, as it is solvable very easily with x as the only unknown quantity. The difficulty is with the last solution submitted by Mr. Duncan, of Dunbar, Pa. Will you or Mr. Duncan kindly explain the arithmetical reason for dividing the difference of the squares of the perpendicular and base by twice the perpendicular? What mathematical authority is there for solving the question this way? I think the formulas are:

1. $\sqrt{\text{Base}^2 + \text{perpendicular}^2} = \text{hypothenuse}$.
2. $\sqrt{\text{Hypothenuse}^2 - \text{Base}^2} = \text{perpendicular}$.
3. $\sqrt{\text{Hypothenuse}^2 - \text{perpendicular}^2} = \text{base}$.

By what rule of arithmetical reasoning does Mr. Duncan solve this problem? His formula is:

$$[(120^2) - 100^2)] \div 2 \times 120 = \text{ans.}$$

Why does he divide the result of the brackets by 2×120, which is twice the perpendicular? An explanation will be gratefully appreciated by many of your readers. Yours, sincerely, J. E. WATKINS,

May 27, 1896. Taylor, Pa.

Broken Shaft.

Editor Colliery Engineer and Metal Miner:

SIR:—Please publish the following as my solution of Mr. Noll's question regarding the broken shaft, in March issue:

QUES.—At Kangley Mine we have an endless rope system of haulage with 2½ miles of ¾″ crucible steel wire rope worked with an engine of the Litchfield pattern with 12″x20″ cylinders and a 7 foot cog-wheel, to which is attached a 4 foot drum. Placed 3 feet behind this drum is another drum which is equipped with Walker's slide rings. This drum is not connected with the engine, but is worked by the rope passing from the forward drum back to the Walker drum with five laps, thence to the tension wheel, and on to the inside. The shaft, which is a six-inch one, has broken at two different times within four months. What would cause the breakage of such a large shaft, it being only 4 feet long? Could the variations in the grooves of the drum made by the wear of the rope cause the fracture?

If the drums were not set true with each other, would that cause the break?

ANS.—The rope that pulls the loads has the greater strain, and will groove the drums deeper than the rope on the end that leaves the drums, thereby making the circumference of the drums smaller on the end that receives the ropes than they are on the other end (especially is this so if the drums are wood lagged). This forms a gigantic differential pulley, and the ropes must either slip or the shaft must break. There are five laps on the drums, making ten ¾″ steel ropes, whose combined breaking strain would be 220 tons for 7 strand rope. Hence, the shaft must break before the rope.

J. S. CHEW, What Cheer, Ia.

May 22, 1896.

Algebra.

Editor Colliery Engineer and Metal Miner:

SIR:—Please publish the following in your next issue in reply to J. P. Wolfe, Big Stone Gap, Va.

A and B dig a ditch 100 feet long for $100. Each receives $50.00; but A receives 25 cents per foot more than B; how many feet does each dig?

ANS.—As A receives 25 cents per foot more than B, it follows that A will dig ½ of ¼ of 100 feet less than B. Therefore, if we take ½ of ¼ of 100 feet from 50 feet (which is half the length of the ditch), we will then have the amount of feet to be dug by A, which will be 50 — (½ of ¼ of 100) = 43.975 feet. The amount per foot will be found by dividing fifty dollars by the amount in feet of the ditch dug. Therefore, the amount per foot that A will receive will be $50.00 ÷ 43.975 = $1.13[illegible] per foot. Now, as B receives 25 cents per square foot less than A, it follows that he will dig ½ of ¼ of 100 feet more ditch than A. Therefore, the length of ditch in feet dug by B will be 50 + (½ of ¼ of 100) = 56.025 feet. The amount per foot will be found as in case "A." Thus, 50 ÷ 56.025 = 89[illegible] cents per foot. C. R. SCUBBAH,

June 12, 1896. Braceville, Ill.

Let x = number feet A digs.

$100 - x$ = number feet B digs.

$\frac{50}{x}$ = dollars per foot A receives.

$\frac{50}{100 - x}$ = dollars per foot B receives.

Then, since A receives 25 cents more than B, the equation becomes

$$\frac{50}{x} - \frac{50}{100 - x} = \tfrac{1}{4}.$$

Clearing of fractions,

$$20{,}000 - 200x - 200x = 100x - x^2.$$

Transposing and collecting, $x^2 - 500x = -20{,}000$.

Whence, $x = 250 \pm \sqrt{62{,}500 - 20{,}000}$.

$x = 250 \pm \sqrt{42{,}500}$.

$x = 250 \pm 206.15 +$.

$x = 456.15$ ft., or 43.85 ft.

The first is visibly not right; therefore,

$x = 43.85$ ft.

$100 - x = 56.15$ ft.

$\left.\begin{array}{l}\text{A digs } 43.85 + \text{ ft.}\\ \text{B digs } 56.15 + \text{ ft.}\end{array}\right\}$ Answer.

Respectfully yours,

JOHN G. SMYTH,

June 8, 1896. Wilkes-Barre, Pa.

[We have also received a solution similar to the latter from W. S. Cope, McDowell, W. Va.—ED.]

The Fifth and Higher Roots.

Editor Colliery Engineer and Metal Miner:

SIR:—To afford a comparison of the practical value of the different methods of extracting the fifth root, permit me to find, by the method I proposed in your March number, the fifth root of 21035.8, which root has already been found by the methods proposed by Ajax and Mr. Hannah. Let $b = 7^5$ = the fifth power of the trial root. Then,

$$K = 2\left[\frac{21035.8 - 7^5}{21035.8 + 7^5} + \tfrac{1}{3}\left(\frac{21035.8 - 7^5}{21035.8 + 7^5}\right)^3 + \tfrac{1}{5}\left(\frac{21035.8 - 7^5}{21035.8 + 7^5}\right)^5 + \right] = .2244302 +.$$

Substituting this value of K in the following equation, we have

$$x = 1 + \frac{K}{5} + \frac{K^2}{1 \times 2 \times 5^2} + \frac{K^3}{1 \times 2 \times 3 \times 5^3} + = 1.0459086 +.$$

$$\sqrt[5]{21035.8} = 7 \times 1.0459086 + = 7.321360 +.$$

Again to find the 10th root of 1,000. Let $b = 2^{10}$. Then,

$$K = 2\left[\frac{1{,}000 - 2^{10}}{1{,}000 + 2^{10}} + \tfrac{1}{3}\left(\frac{1{,}000 - 2^{10}}{1{,}000 + 2^{10}}\right)^3 + \tfrac{1}{5}\left(\frac{1{,}000 - 2^{10}}{1{,}000 + 2^{10}}\right)^5 + \right] = -.0237165266731 +.$$

Substituting this value of K in the following, we have

$$x = 1 + \frac{K}{10} + \frac{K^2}{1 \times 2 \times 10^2} + \frac{K^3}{1 \times 2 \times 3 \times 10^3} + \frac{K^4}{1 \times 2 \times 3 \times 4 \times 10^4} = .9976311574963 +.$$

Multiplying this value of x by 2,

$$\sqrt[10]{1{,}000} = 1.9952623149926 +.$$

It will be seen that the degree of accuracy attainable by the foregoing method is much greater than can be had by the use of a table of 6 figure logarithms.

Yours, etc., S. A. COREY,

June 10, 1896. Hiteman, Ia.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of $1.00 in any of the books in our book catalogue, or six months' subscription to THE COLLIERY ENGINEER AND METAL MINER.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue or three months subscription to THE COLLIERY ENGINEER AND METAL MINER.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to THE COLLIERY ENGINEER AND METAL MINER.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed us not later than one month after publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Competition Questions for July.

QUES. 235. Can you suggest some new and improved arrangement by which we can dispense with the wire gauze cylinder in our new safety lamp? Do you think we could substitute for the meshes of the gauze an annular space between two short tubes? and if you do, show how a flame passing through a relatively long space of annular section would more effectively quench a flame than the fine wires of a mesh.

QUES. 236. Please look at a map of the North American continent and find for me the longitude of St. John's, situated on the easternmost coast of Newfoundland, and the longitude of Cape Flatte, situated on the westernmost coast of the United States; and having found the two longitudes, show what would be the time of day at St. John's when it was 12 o'clock, noon, at Cape Flatte. Please also explain how you calculate the time for St. John's.

QUES. 237. We have contracted to work a large royalty of 1,000 acres of very fine coking coal, and the whole of it, except a small patch where we have sunk the shafts, lies under a lake. The seam is 5 feet thick and pitches from the shafts in the direction of its greatest length at the rate of one foot vertical for every 20 feet horizontal. The rock above the seam is a soft slaty limestone, and admits much water, and on this account I hope you will repeat your former acts of kindness and explain to me with the help of a diagram how you think I should work this coal to keep the working face dry and avoid much expense in the general drainage.

QUES. 238. What system of pumping would you adopt, in working the seam mentioned in the former question, to discharge the water feeders of the mine into the sump at the bottom of the pumping shaft?

QUES. 239. It has been repeatedly observed that in a rectangular hoisting shaft where the cages are nearly as long as the shaft is wide, the horse power of the hoisting engines has to be increased in the proportion of the square root of the cubes of the velocities, instead of as you would think, directly as the velocities; as for example let v be the velocity, then the power required is in the proportion of $\sqrt{v^3}$. Can you give me a good reason for this singular increasing resistance that occurs in hoisting with large cages in rectangular shafts?

QUES. 240. A pound of coal, when burnt, develops 11,000 heat units, English. At what velocity, then, would this piece of coal have to move through space to store up as much mechanical energy in its mass as would be exactly equal to the mechanical equivalent of the heat units due to its combustion. State the result in miles per hour.

Answers to Questions which Appeared in the May Issue and for which Prizes Have Been Awarded.

QUES. 215.—In surveying around the bottom of a mountain, we made all the necessary levels and insets to determine the correct figure of a truly horizontal base that was just touched by the western side of an outcropping coal seam. From the plat we found the figure to be practically that of an ellipse, with its major axis coursing from south to north 6,012 feet, and the minor axis coursing from east to west for 2,842 feet. The mountain is 1,800 feet high. The coal seam is 4 feet thick, and is overlaid with a strong sandstone. We levelled our transit at a distance of 64 feet eastward of the eastern end of the minor axis, and with the center of the telescope at an elevation of 4 feet 1 inch above the calculated level of the base, the bottom of the coal seam here made an angle of elevation of 38° 26′, and the distance, measured in a straight line from the plumb point on the ground to the bottom of the coal seam, was found to be 1,025 feet. Now, I wish to know three things that I am sure you will calculate for me.

First—What is the pitch of the seam?

Second—What is the area of the seam?

Third—What percentage of this seam could be reasonably worked? Show with a sketch how you find the pitch.

We are sorry to say this question has again been attempted and all have failed. One gentleman sent in a good solution but he took the minor axis at 2,482 instead of 2,842. Another gave the contents instead of the area for the second request.—EDITOR.

QUES. 222.—In a mine shaft in course of being sunk an iron kettle full of water was hoisted from the bottom at a mean velocity of 6 feet per second. The kettle was cylindrical in shape and 3.5 feet in diameter and 3.5 feet deep, and by some unknown cause a round hole had been cut through the bottom, and it had a mean diameter of 3 inches. The result was that the kettle left the sump in the shaft bottom full of water and arrived at the top of the shaft empty, and by coincidence the discharge of water just ceased at the moment the kettle reached the surface. Now, I will be obliged if you will deduce for me, out of these facts, the depth to which the sinking has advanced.

ANS.—The contents of the kettle in cylindrical feet are $3.5^3 = 42.875$. The contents of the kettle in cylinders 3 inches in diameter and 12 inches in length are $42.875 \times 16 = 686$. The mean velocity of discharge is

$$\sqrt{\frac{3.5 \times 64.4}{2}} \times .62 = 6.5819 \text{ feet per second.}$$

The time of discharge is

$$\frac{686}{\sqrt{3.5 \div 2 \times 64.4} \times .62} = 104.2246 \text{ seconds.}$$

The height to which the kettle would rise to empty, or the depth of the sinking, is $104.2246 \times 6 = 625.3476$ feet.

P. J. WALSH, Lemont Furnace, Pa.

Second Prize, MORGAN D. ROSSER, Kingston, Pa.

QUES. 223.—In trying to find out the combustible substance that would give the best results in generating the flame in our new safety lamp, I have fallen across the following facts that completely puzzle me, and as I am afraid that any further attempts to solve the riddle would drive me to distraction, I will be obliged to you if you will show to me how it occurs that when two volumes of pure hydrogen combine with one volume of oxygen, more heat is given off than when one volume of marsh gas combines with two volumes of oxygen. One thing I have noticed that may help you to find an answer, and that is, the hydrogen and oxygen produce water that is a liquid, whereas the marsh gas and oxygen produce liquid water and a permanent gas, and, strange to say, coal gas that contains a high percentage of $C_2 H_4$ gives off less heat than $C H_4$, and oils, such as are burned in lamps, give off less heat per unit of weight than any of the gases under notice, and yet we know that a large percentage of energy is concealed somehow in burning these hydro-carbons, but it is not given off as heat, but I have no doubt you can tell me something that will remove the mystery.

ANS.—The calorific power of hydrogen is 34,462 and 2 parts of H unite with 8 times its weight of oxygen in burning to steam whose specific heat is 0.4805. Hence the maximum temperature of combustion or "heat given out" will be

$$\frac{34,462 - (8+1)(51.95 + 537)}{(8+1) \times 0.4805} = 6,743° \text{ C.} \quad (1).$$

In this a correction for the latent heat of steam 537° C., and for the difference between the specific heats of water and steam, 51.95 is made.

The calorific power of $C H_4$ is $\frac{(3 \times 8080) + 34,462}{4} = 14,678$ $\left(C = \frac{16}{16+4} ; H = \frac{4}{16+4}\right)$ and 1 part of $C H_4$ unites with 3.2 parts of 2 O_2 ($= 4 \times 16 = 64$) to form $2 H_2 O + C O_2$ in the relative weights of $(3.2 + 1) \times \frac{36}{80} = 2.01$, and $4.2 - 2.01 = 2.19$, whose specific heats are 0.4805 and 0.2164.

Hence,

$$T = \frac{14,678 - [2.01 \times (51.95 + 537)]}{2 \times [(2.01 \times .4805) + (2.19 \times .2164)]} = 4,685° \text{C.} \quad (2)$$

Hence we see from (1) and (2) that hydrogen develops the greater heat as stated.

CHAS. ED. BOWRON, Tracy City, Tenn.

QUES. 224.—All the plants in the vegetable kingdom of life are grouped under four distinct divisions, as Thallogens, Acrogens, Endogens, and Exogens. Will you, therefore, name for me a single example in each division that flourished during the Carboniferous period, and also a single example in each division of plants that are living now in your state or country?

ANS.—The four great divisions of the vegetable kingdom to which the question refers were represented during the Carboniferous period by such examples as are here given:

Sub Kingdoms.	*Representative Plants.*
Thallogens.	Lichens.
Acrogens.	Calamites.
Endogens.	Grasses.
Exogens.	Coniferae.

The sub-kingdoms in the vegetable world are now the same as they were during the Carboniferous period, and the four representative examples required for this state (Pennsylvania) are:—

Sub Kingdoms.	*Representative Plants.*
Thallogens.	Mushroom.
Acrogens.	Horse Tails.
Endogens.	Grasses.
Exogens.	Pines.

JOSEPH VIRGIN,
Mine Superintendent, Hosopple, Pa.

Second Prize, CHAS. E. BOWRON, Tracy City, Tenn.

QUES. 225.—A mine shaft is 3,000 feet deep, and I wish to know what weight a first-class steel rope, $1\frac{1}{2}$ inches in diameter, will safely carry in hoisting coal up this shaft.

ANS.—Weight of 19-wire strand plow steel hoisting rope, $1\frac{1}{2}$ inches in diameter, with hemp center, is 3.65 pounds per foot.

$$\frac{3,000 \times 3.65}{2,000} = 5.475 \text{ tons' weight of rope.}$$

Breaking load is 110 tons and safe working load with factor of safety $= 5$ is $\frac{110}{5} = 22$ tons.

$22 - 5.475 = 16.525$ tons gross weight cage and load.

CHAS. ED. BOWRON, Tracy City, Tenn.

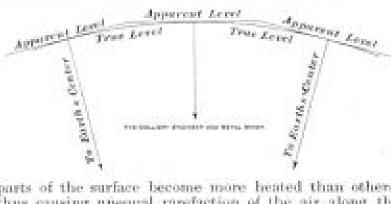
Second Prize, A. W. EVANS, Petros, Tenn.

QUES. 226.—Will you explain to me, with a neat drawing, how it occurs that the horizontal planes at the two ends of a perfectly straight line of sight are never parallel, although the telescope is set truly level at the ends in question? Again, while you are busy, you might show me how it is that we cannot get a "perfectly straight" line of sight, and the longer that line is, the greater is the divergence. Further, make a bold finish by showing the reason why a sight made over a surface heated with the rays of the sun can never be trusted for accuracy.

ANS.—A line is said to be level (apparently), when it forms a right angle with the earth's radius or is tangent thereto. That the planes at the end of the line are not parallel is due to the spherical shape of the earth. The divergence of the planes from the apparent level depends upon the distance between them. When this distance is small, the angle of divergence will deflect so little from the apparent level that the planes seem to be parallel, but as a matter of fact, they are not.

The cause why a perfectly straight line of sight cannot be obtained is due to the rays of light passing through the air being curved downward. This downward curvature makes the point sighted to appear at a higher level than it actually occupies and the result is a broken line that will be somewhat longer than the true line, and the longer the line of sight the greater the difference.

The reason why a sight made over a surface heated with the rays of the sun cannot be trusted is that some



parts of the surface become more heated than others, thus causing unequal rarefaction of the air along the line of sight and consequently irregular refraction, that makes correct calculation impossible.

JOHN VERNER, Lucas, Iowa.

Second Prize, A. W. EVANS, Petros, Tenn.

QUES. 227.—To work a valuable coal seam, we must deliver onto the nearest railway with a branch road of our own, and as the surface is very uneven, and the possible duration of the seam does not warrant the making of cuttings and embankments, we will deem it a favor if you will advise us about the haulage we should make to be cheap in construction and efficient in action; and, if possible, please support your conclusions by reference to actual cases; and be careful to note that we have decided against every kind of locomotive traction.

ANS.—In this case, where the surface of the ground is very rugged in contour, I would for cheapness of construction and efficiency in action advise the construction of a wire rope tramway, on the double rope system. One of the chief advantages of this system is its capability of surmounting any grade. By using the Bleichert system you have a regular service and few stoppages for repairs and no interruptions due to atmospheric influences or any interferences on account of surface traffic. The expenses of operating are very low. Terminals can be established at the places most convenient for receiving and delivering. These facts just noticed prove the advantages of wire rope tramways where the grading is very irregular. The Bi-Metallic Mining Co. of Granite, Montana, has a tramway 9,750 feet in length, with a fall of 1,225 feet. The descending load develops 14 horsepower, which is used to run the crusher and elevator, capacity 250 tons in 10 hours. Cost of transportation 5 cents per ton per mile.

The Granite Mountain Mining Co. line at Rumsey, Montana, is 8,750 feet long, with a fall of 1,297 feet and develops over 14 horse-power. There is a span of 600 feet and from Fred Burr hill down to the mill at Rumsey, the grade is usually so steep as to fall 1' in 2'.

The Split Rock Cable Road Co. of Syracuse, N. Y., has in operation a line 16,500 feet long. Daily capacity 750 tons.

There exists in nature hardly a supposable difficulty, which would bar the introduction of this system of transportation. I would advise the owner of this valuable property to inaugurate a correspondence with the Trenton Iron Co., Trenton, N. J., and the Lidgerwood Mfg. Co., New York City.

A.W. EVANS, Petros, Tenn.

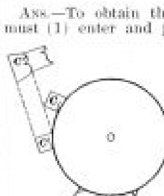
Second Prize, CHAS. E. BOWRON, Tracy City, Tenn.

QUES. 228.—Sometimes in mining, where the seam is situated above the drainage level of the district, water can be collected at the surface and conveyed down the shaft in pipes to do the work required in pumping, hauling and ventilating. This great water power is applied through the medium of hydraulic engines, in which a stream of high pressed water is projected onto reaction blades, whose surfaces are curved to secure total reflection instead of simple deflection. Now, to make sure that we all understand the explanation given, will you still further assist us by answering two questions?

First—What are the curves that are given to the inside surfaces of the reflecting cups, of the reflex water wheel?

Second—Show by a sketch and the necessary explanation, that with total reflection more power is obtained than could be secured with a deflection of 90° from the plane of the wheel's rotation?

ANS.—To obtain the highest efficiency the water must (1) enter and pass through the wheel without loss by friction and foam and (2) must reach the tail-race without absolute velocity. With cups which are merely radial vanes as in the California "Hurdy-gurdy" shown at A, the impinging jet of water N is deflected 90° to B and passes away with considerable velocity while with properly curved vanes shown at c, c', the jet is reflected 180°, thus producing as much energy from its reaction as from its action or double that of the radial straight vanes, their relative efficiencies being as 40 to 80% of the theoretical water power. For complete reflection the inside surfaces of the reflecting cups are parabolic.



CHAS. ED. BOWRON,
Tracy City, Tenn.

The Care of Mine Mules.

Every mine manager and operator knows that notwithstanding the mule is a hardy and tough animal, he is afflicted with certain diseases, and is either incapacitated for a time at least, or dies, entailing considerable loss. Besides, many mine mules are totally incapacitated by injuries that if properly handled would result only in temporary disablement.

It is a recognized fact that in man, the highest order of animal life, the stomach is the most important factor in determining the degree of health enjoyed, and that if the stomach and digestive organs are in perfect condition, the bodily health of a man is good and he is physically able to do a large amount of labor. This same condition exists in mules and horses. The leading stock breeders of the world recognize this fact and profit by it.

We do not believe in advertising in this journal any preparation or appliance that has not received unqualified endorsement from some mine manager or other official in whom we have confidence, as we believe it is our province to not only publish such articles as are practical and useful to mining men, but to keep our advertising columns free from advertisements of a doubtful character. Before accepting an advertisement of "Nutriotone," we found that it had been used with excellent results for several years by the Lackawanna Coal Co., the Mt. Jessup Coal Co., the New York and Scranton Coal Co., and the Sterrick Creek Coal Co., all operating mines in close proximity to Scranton. Each of these companies unqualifiedly endorse the preparation.

Nutriotone is just what its name implies. It is a restorative and nutritive tonic,—a perfect food auxilliary. It is intended to supply the restorative elements generally wanting in ordinary feed in proper proportion to satisfy all the demands of the animal system. It thus improves the appetite, aids digestion, promotes assimilation, and increases the activity of all the functions of the animal economy, so that the tone of the system is maintained in normal condition, and possibilities of growth and development intensified. It is a natural remedy for the petty ills of the animal system in its restorative action, and prevents the graver ills and diseases by keeping the system in condition whereby attacks may be thrown off. It contains no mineral or organic poisons, but it consists of purely vegetable and mineral substances, which are so combined as to furnish the elements most needed to meet the demands of Nature. Its effect is such, that besides curing the diseases of mules and horses, it tones up their systems so that wounds and injuries heal up in remarkably short time. It may be administered in almost any quantity, and its use may be entrusted to any stableman of average intelligence. It is not intended for a food, but it should be used as a supplement, or in addition to ordinary foods.

Nutriotone is manufactured by the Thorley Food Co., of 40-42 Franklin Street, Chicago, Ill., and 312-313 Kirk Building, Syracuse, N. Y. In the Northern Anthracite Field, it is handled at present by the Weston Mill Co., of Scranton and Carbondale, Pa., and J. T. Nyhart, Peckville, Pa. It is a preparation that merits the attention of mine managers generally.

A Large Shipment of Electrical Mining Apparatus.

One of the largest single shipments of electrical apparatus was shipped recently by the Westinghouse Electric and Manufacturing Company to Great Falls, Montana. The shipment filled eight freight cars and the freight of that cargo to its destination amounted to $8,000.

The machinery will be used by the Boston and Montana Consolidated Copper and Silver Mining Company in the refining of copper and silver, and it is the largest machinery of its kind ever constructed for electrical refining purposes. The Boston and Montana Company is one of the largest copper mining concerns in the northwest.

Until a few years ago the copper produced in that country was not refined, but the copper matte was sent east, some of it to England, and then refined. Since the introduction of electricity into the refining process, the companies are in a position to compete with the East.

The Anaconda Mining Company purchased from Westinghouse some time ago seven 360 horse-power generators, of an output of 3,600 amperes each at 75 volts. Since these machines have been in operation the electrical process of refining has proved a great success. The machinery of the Boston Company will be driven by turbines from the waters of Great Falls.

The generators will be directly connected with the turbines. There are two of them, the largest ever made, each one of 1,100 horse power, at an output of 4,500 amperes and 180 volts. These machines were shipped in four freight cars, while the others were filled with detail apparatus, such as switchboard appliances, etc.

LEGAL DECISIONS ON MINING QUESTIONS.

Purchase by Cotenant of Mining Claims.—A tenant in common in a junior mining claim cannot buy in the title of a senior conflicting mining location, and assert it against his cotenant in the junior claim.

Franklin Mining Co. v. O'Brien (Supreme Ct., Colo.) 43 Pacific Reporter, 1,016.

Who are Not Fellow Servants.—The foreman of a stone quarry (or similar business) owned by a corporation, whose duties require him to exercise a general superintendence over the men, and to make and abrogate rules for their guidance, is not a fellow servant with one of the men.

Richmond Granite Co. v. Bailey (Sup. Ct., App. Va.) 24 S. E. Rep. 232.

Foreign Corporations May Buy and Sell Mining Lands in North Carolina.—A foreign corporation created for the purpose of mining and milling gold and other minerals in the state may, if not prevented by its charter, acquire and dispose of real property in the furtherance of the objects of its creation.

Barcello v. Hapgood, (Supreme Ct. N. C.) 24 S. E. Reporter, 124.

Measure of Compensation for Taking Mineral Lands for Public Uses.—Where, in proceedings to condemn a right of way across land, the evidence shows that part of the land is underlaid with mineral limestone, the extent to which that fact would tend to increase its market value is for the determination of the jury.

Sanitary Dist., Chic. v. Loughran (Supreme Ct. Ills.) 43, N. E. R. 359.

Trespass by Agent of Mining Company.—That the agent of a mining corporation, in mining coal in certain land, acted under the belief that the coal was owned by the company, when in fact it did not have even color of title, there being no mistake in the identity of the land, does not prevent trespass from being an intentional one.

Sunnyside Coal & Coke Co. v. Reitz (App. Ct. Ind.) 43 N. E. Rep. 47.

When Punitive Damages Will Not Be Allowed.—In the absence of evidence, in a personal damage suit against a coal company, of malice or reckless conduct on the part of the company indicating a purpose to have the employe injured, or of a reckless disregard of the safety of the person of the employe, the jury should be confined, in case they return a verdict against the company, to compensatory damages only.

McHenry Coal Co. v. Sneddon (Ct. App. Ky.) 34 S.W. Rep. 228.

Non-Liability of Coal Company for Injury to Employe.—An employer was not liable for the death of an employe by his falling after having been caught by a rope, part of a hoisting apparatus, which commenced to tighten up just as he was stepping over it, where the employe was fully acquainted with the apparatus, and it was working as usual on the day of the accident, and the employe had been forbidden, and his duties did not require that he should cross the rope.

O'Brien v. Staples Coal Co. (Sup. Jud. Ct., Mass.) 43 N. E. Reporter, 181.

Injunction: Mining Claim.—Where the showing made by a party desiring a preliminary injunction tended to prove that the other party, as lessee of the owners of an interest in certain mining claims, in which the complainant owns the largest interest, was working such claims without the consent and against the wishes of the complainant, and not dividing the proceeds in good faith, such showing is sufficient to justify the injunction, in the discretion of the trial court, on the ground that the acts of the other party constituted an exercising of exclusive ownership by one tenant in common.

Red Mt. Consol. Min. Co. v. Essler (Supreme Ct. Montana) 44 Pacific Reporter, 523.

Engineer and Excavation Contract.—A contract for the excavation of ground, for the erection of an inclined plane, provided that the work should be done "according to the directions and under the supervision of the engineer in charge of the construction of the incline" and the work was to be paid for at a certain rate per cubic yard. The Supreme Court of Pennsylvania held that, the contractor had no right of action, when the planes in the incline were so changed as to leave no earth excavation to be done, on account of the loss of possible profits, unless such excavation was directed by the engineer in charge.

Huckestine v. Nunnery Hill Incline Plane Co. 35 Atlantic Reporter, 1,108.

Location of Mining Claims in Town Limits.—The fact that land on which discovery and location of a mining claim are made is within the patent limits of a town will not affect the title of a locator, where it was known prior to the patent of the town that valuable mineral veins existed where the discovery and location were made afterwards.

In ejectment for a mining claim, where it appears that the discovery shafts of both parties are identical, evidence that the discoveries were made on lands patented prior to the dates of discovery of either party should be admitted, and the jury instructed if that fact were found, neither party could recover.

Moyle v. Bullene (Ct. App. Col.) 44 Pacific Reporter, 69.

Construction of Contract of Guaranty.—A party made a contract with another by which he gave the latter the sole agency of the sale of the output of a colliery, "at all points along the line of the N. R. Co., its branches and connections," and agreed to fill all orders for coal sold by such party to any persons at such points. The court held that coal delivered at one of the termini of the road on coal docks leased by it and under its control was within the contract, and therefore within a guaranty by a third party of payment by the second party of money becoming due thereunder. Also, that such contract could not be limited by parol to a particular kind of coal from said colliery.

Hutchinson v. Root (Sup. Ct. App. Div. 1st Dept.) 38 N. Y. S. Reporter, 16.

Deed of Trust on Mining Property.—Where the deed of trust on the property of a mining company does not cover the profits arising from the business, the profits accruing before the commencement of an action cannot be intercepted by the appointment of a receiver, and applied upon the mortgage debt, either directly or indirectly, through the use of same in the operation of the business. Where the deed covered all the "personal property of every kind, now owned or hereafter to be acquired and owned and used, in connection with and for use in developing and operating its said coal mines"; authorizing the grantor to take and use the rents and income until default, such mortgage did not cover the profits or proceeds of the business of mining, such as coal, coke, and iron mined and manufactured, and accounts from the sale of same.

Ala. Nat. Bank v. Mary Lee Coal & Ry. Co. (Sup. Ct. Ala.) 19 So. Reporter, 404.

Illegal Combinations.—A statute denouncing as void and prohibiting the enforcement at law or in equity of every contract whereby a combination of capital, skill, or arts is formed to create or carry out restrictions in "trade," or prevent competition in the sale or purchase of "commodities," renders void a lease by a coal company of a saloon on its property, in which the lessor covenants not to permit the sale of liquor, to any one else on its lands, and to issue to its employes checks in payment of wages, and to redeem all checks which the lessee might take in payment for liquors in consideration of the payment as rent of two-thirds of the profits of the business.

Texas & P. Coal Co. v. Lawson (Supreme Ct. Tex.) 34 S. W. Rep. 919.

Fire in Mine: Contributory Negligence of Miner.—Where a miner after having been notified of the outbreak of a fire in a mine in time to permit him to reach the shaft in safety, unnecessarily lingered in the mine, without notifying the men on the surface of his intention to do so, and it appears it would have been proper to stop a fan, which caused a circulation of air in the mine, or keep it running according to the location of the fire, a nonsuit, on the ground of contributory negligence should be granted in an action to recover for his death, as said miner had no right to assume that those in charge of the fan knew the location of the fire, though the jury also find that the negligence of the mining company in stopping the fan was one of the concurrent causes resulting in the death of such miner.

Pugh v. Oregon Imp. Co. (Supreme Ct. Wash.) 44 Pacific Rep. 547.

Assignment of Lease of Coal Mine.—A lease of a coal mine obligated the lessor not to lease to any other party any coal land to be operated during the life of the lease, and prevented the lessee from dividing his time or attention with any other mine for the reason that the rent depended upon the number of bushels mined. The lessee assigned his interests in the lease, and the assignees sought to restrain him from operating another mine, on the ground that he was still bound by the original lease. The Supreme court of Iowa held that no right to insist on the obligation between the lessor and the lessee was transferred to the assignees, but that they acquired only such rights as their assignor had under the lease, and were bound in his stead by the obligations. An assignment of a lease of a coal mine, with the good will of the trade, does not carry with it an obligation that the assignor will not again engage in the same business in the vicinity.

Fidlay v. Carson, 66 N. W. Reporter, 759.

Mining Claim—Failure to do Assessment Work, etc.—The owner of a placer mineral claim does not forfeit his right to same, so as to render it subject to relocation, by failure to perform the required annual assessment work during a time when adverse possession is held by another, when he commences an action for its recovery within the statutory time.

Where the owner of such a claim, which was erroneously included in a sale under a decree of court, moved his effects from the claim, and absented himself for two years, allowing the purchasers to work it without objection, while he knew that their title was invalid, and intending to claim it only in case their development rendered it profitable to do so, his acts will constitute an abandonment.

Trevaskis v. Peard (Supreme Ct. Cal.) 44 Pacific Reporter, 246.

Hydraulic Mining.—An injunction, says the Supreme Court of California, will not be granted against the use by a mining company of a ditch, across the land of another, for carrying detritus from an hydraulic mine, on the ground of an improper and injurious exercise of the easement, where it appears that the water in the ditch caused a slight caving in of the land of the complainant, but did not cause or threaten any appreciable danger. Also, that in an action to abate, as a nuisance, such ditch, evidence of a custom of using such ditch in all hydraulic mining is admissible. And further that, under the laws of the United States, a patentee of mining land, over which an adjoining owner had for several years, by local custom, and from necessity, maintained such ditch to a river, took subject to the easement, or right of the mining company to use the ditch for such purpose across the patented lands of the other.

Jacob v. Day, 44 Pacific Reporter, 243.

Responsibility for Injuries in Coke Yard.—Where a party was employed in a coke yard, and was directed to clean the sprocket wheel of a slack elevator by the foreman of the company, it being the duty of the foreman to control, employ and discharge such men, and to look after and keep the machinery in repair and running order, and such party was injured on account of the negligence of this foreman in failing to delay the starting of the machinery, and also in failing to detach the chain by which the elevator was operated, the Appellate Court of Indiana says that such employe cannot recover for the injury, unless he shows that the foreman's negligence was the omission of a duty owing by the company to the employe, the discharge of which duty was intrusted by the company to the foreman.

New Pittsburg Coal & Coke Co. v. Peterson, 43 N. E. Rep. 270.

Coal Lands—Agreement to Sell, Adverse Possession, etc.—The effect of the record of articles of agreement, showing the purchase of the coal on certain land from the equitable owner, as notice to all the world, is not affected by the fact that the legal owner of the premises subsequently gives to the former vendor a deed vesting in him a complete title to the premises.

The possession of the surface of the land is in no way adverse to the right of possession of coal beneath the surface by another under an agreement for the sale of such coal. And, the purchaser of coal beneath the surface is not bound to take actual possession in order to preserve his title to it.

A recorded contract for the sale of a tract of land, and also of coal beneath the surface of an adjoining tract, by the equitable owner of such properties, is not merged in a subsequent deed of the latter tract by the legal owner to the purchaser.

Lulay v. Barnes (Supreme Ct. Penna.) 34 Atlantic Reporter, 52.

Apportioning Interests in Mining Claims.—The owners of a certain mining claim and the owners of sundry adjacent claims, between whom and the owners of the first claim there had been disputes as to their respective rights in certain locations, organized a mining company, and conveyed to it their various rights in the disputed locations. One half of the stock was assigned to the owners of the first claim. The other half was placed in trust for the owners of other claims, who could not agree upon a division of the stock, with an understanding that account should be taken of the ore from the several locations, and the proceeds, after deducting one-half for the owners of the first claim, should be paid to the grantors of the several claims. Subsequently, in a suit brought by third parties against the assumed owners of a mine on one of the disputed claims, it was adjudged that an interest in the location belonged to such third parties. The court held that in the absence of some of the parties interested in the stock of said mining company, held in trust, the court could not, in such suit apportion the stock so held, and direct a transfer of the shares, but that the most that could be done was to adjudge that the assumed owners of the disputed mine should transfer a proportion of such interest as they had in such stock to the parties found to have an interest in the location.

Wheeler v. Billings (U. S. Cir. Ct. App.) 72 Federal Reporter, 301.

Coal Production of the United States in 1895.

Mr. E. W. Parker, statistician of the United States geological survey, has completed the compilation of the statistics of coal produced in the United States during the calendar year 1895. The total output from all mines was 171,804,742 long tons, or 192,420,411 short tons, having a total value at the mines of $197,572,477. This shows an increase over the production in 1894 of about 19,350,000 long tons, and an increase in value of about $11,500,000. The output of anthracite coal in Pennsylvania increased from 46,358,144 long tons in 1894 to 51,785,122 long tons in 1895, a gain of over 5,400,000 long tons. The value increased only about $3,500,000, from $78,488,063 to $82,019,272, showing that anthracite coal was cheaper in 1895 than in 1894.

The product of bituminous coal increased from 118,820,405 short tons of 2,000 pounds in 1894 to 134,421,974 short tons in 1895, a gain of over 15,500,000 tons. The value increased about $8,000,000. There was an increased production in all but five of the twenty-nine coal producing states. Alabama and Pennsylvania showed phenomenal gains of more than 25 per cent., Alabama increasing from 4,397,178 short tons in 1894 to 5,679,775 tons in 1895, with a valuation of $5,348,796, and Pennsylvania from 39,912,463 short tons to 50,017,446 short tons, valued at $35,902,678. The states in which a decreased product was shown were Georgia, Kansas, North Dakota, West Virginia and Wyoming. The principal loser was Kansas.

The following table gives the production of the several states:

States.	Short Tons. 1895.	Value. 1895.
Alabama	5,679,775	$ 5,348,796
Arkansas	598,322	752,156
California	75,453	155,778
Colorado	3,056,000	3,666,828
Georgia	260,998	215,863
Illinois	17,735,864	14,239,157
Indiana	4,090,554	3,651,883
Indian Territory	1,350,965	1,733,454
Iowa	4,192,659	5,036,289
Kansas	2,334,356	3,112,306
Kentucky	3,207,770	2,702,747
Maryland	3,915,585	3,160,592
Michigan	112,322	180,016
Missouri	2,360,350	2,703,675
Montana	1,489,193	2,815,906
New Mexico	718,554	1,070,320
North Carolina	24,900	42,350
North and South Dakota	39,197	42,046
Ohio	13,376,137	10,627,533
Oregon	73,685	247,901
Pennsylvania	50,017,446	35,902,678
Tennessee	2,333,304	2,348,182
Texas	484,959	921,138
Utah	459,136	590,649
Virginia	1,340,576	870,465
Washington	1,191,410	2,577,858
West Virginia	11,421,863	7,287,129
Wyoming	2,277,323	3,025,631
Total bituminous	134,421,074	$115,553,205
Pennsylvania anthracite	57,999,337	82,019,272
Grand total	192,420,411	$197,572,477

DOORS IN MINES.

THEIR EFFECT ON THE AIR CURRENTS.

Their Use, Abuse, and the Extent to Which They May be Avoided.

By James Blick, Inspector of Mines.

(Read before a joint meeting of the Western Penna. Central Mining Institute and the Ohio Institute of Mining Engineers).

We have no definite knowledge of the time or place where mine doors were first used, but in all probability they were introduced away back in the early history of mining operations, when the people were groping along in the dark, seeking knowledge the best way they could, to enable them to ventilate their mines; also to find out some method or appliance whereby they could procure a light for use in the underground workings that would not ignite the explosive gas, which was and had been the miners' most deadly enemy from the earliest period of coal mining, an enemy which they were unable to combat, having no means at hand wherewith to expel it from the mines or to detect its presence in the mines until its deadly blasts were upon them. Doubtless the person who introduced the first door into the mines considered (and rightly so) that he had performed an achievement far superior to any previous accomplishment in mine ventilation, and that his newly invented apparatus was the one thing needful, as by its application the mine manager could conduct the air current through every part of the mine and sweep away the deadly gas, thereby removing the danger of explosions which the miners so much dreaded, and which oftentimes suddenly came upon them, like a thief in the night, without the least warning. Probably the mine door, the Davy lamp, and the ventilating furnace were introduced at about the same time, closely followed by the steam jet, all of which were vast improvements upon the most primitive methods of ventilating and lighting of the mines, the first of which consisted of the vigorous shaking of a canvas cloth at the entrance of the mine by some strong, lusty person employed for that purpose; the second consisting of nothing better than a few bright sparks guaranteed by the use of the flint mill; but a brighter day had at last dawned, the mists of ignorance were being pushed aside by intelligent action; the old pioneer miners were now enabled to prosecute their calling with a degree of safety never before experienced. This gave them confidence in their own ability to overcome and remove the many obstacles which had previously blocked their way to progress and prosperity, and had prevented them from extending their operations to such an extent that would satisfy the growing demands for their commodity; and however little value we may place upon the mine door, Davy lamp, furnace, and steam jet at the present day, yet we are compelled to admit and to testify to the fact that the success of the old pioneer operators and miners was in a very large measure due to the introduction of the devices and apparatus before mentioned, and immediately following their introduction the business of coal mining made rapid strides forward; therefore we affirm that the mine door as a means of conducting the air current around

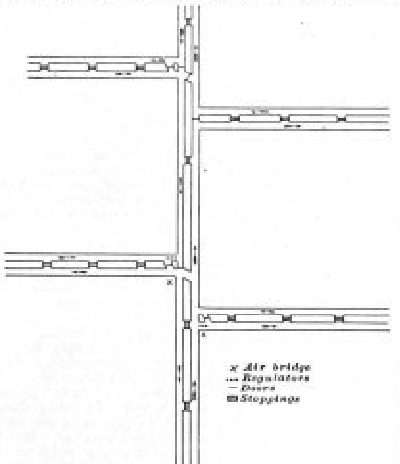


FIG. 1.

and through the various ramifications of the mines was a great improvement upon what had gone before, and was a useful invention which did valuable service in its early history, and it was doubtless the means of preventing the destruction of many valuable lives and much property in those early days. At that time the mine workings were not extensive, and the employes in each mine were few, but since the mines have become deeper, more gaseous, and very extensive, in very many cases employing large numbers of men, it is found that primitive methods and appliances which were useful and beneficial in their day, are no longer satisfactory, efficient, or safe, and instead of being safeguards, they have for some time past been looked upon as man-traps, hence, the name of mine door has been changed to that of trap door.

Who gave it its new name and when and where it received it I know not, but I suppose the change of name was due to its merits, and I feel no inclination to attempt to controvert the assertion often made to the effect that the cause of many explosions can be traced to the use of the trap door. It is impossible to arrive at a close estimate of the number of lives sacrificed and the value of property destroyed by gas explosions in mines by reason of the doors being left standing open, for in nearly all large explosions the destruction is so complete as to render it impossible to ascertain to a certainty, whether open or broken doors were the direct cause of the mischief or not; but there is good reason to believe that were the evidence not so completely obliterated, the source of the trouble in many cases could have been traced to the ever present trap door. By reviewing the history of mine disasters we find that in 1857 an explosion occurred in a mine located in England by which 190 lives were lost and the mine left a complete wreck, several months having elapsed before the bodies were recovered; we are also informed that in this mine at the time of the explosion there were no less than 52 doors

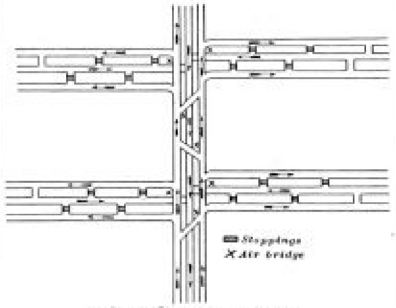


FIG. 2.

in use, and the presumption is very strong, indicating that one or perhaps several of those doors were left open at the same time, which cut off the ventilation for a sufficient length of time to permit the accumulation of a large body of gas, which was supposed to have been ignited some distance from where it was generated, it having been moved thither by the air current after it was again directed through its proper channels by the closing of the doors. I can recall four instances in Western Pennsylvania where loss of life has occurred through the doors having been left open, two cases in Fayette county, in 1884, whereby 15 lives were lost; one case in Westmoreland, in 1887, whereby one man lost his life; and the fourth case in Washington county, in 1893, where one man was killed and another seriously injured, and probably there are parties present who can recall other instances of a similar nature. Explosions are not the only evil effects resulting from the use of doors, for if we go into any mine where they are used to excess we invariably find that the men are compelled to work in a stagnant, impure atmosphere to a greater or less extent, and I venture to assert that the fact of a multitude of doors being in use at any mine is a sure indication that such a mine is not, and cannot at all times be properly ventilated. No matter what the power of the ventilation or how great the volume of air produced, it is next to impossible to maintain a steady, constant flow of air through the workings, for some one or more of the doors in different parts of the mine must of necessity be open much of the time during working hours, and in many cases the effects of even one door being open for a short time only, will result in the disarrangement of the ventilating current throughout a considerable portion of the mine. I am aware that this could be avoided to a certain extent by the use of double sets of doors, so that the one would always be closed before opening the other, but this method entails a considerable item of expense and is only adopted in rare cases.

In view of the evil effects of trap doors in the past we may do well to pause and ask ourselves the question whether we have done our full duty in seeking ways and means to supersede it with something better, or whether we have been careless, resting satisfied with things as handed down to us, when we might have adopted methods more becoming of the advanced age in which we live. I fear our answer to such a question must be somewhat unsatisfactory; for while it is true that our systems of mining of late years have been on the ascendant, still any person with an extensive knowledge and acquaintance of the mining districts of our own and other states at the present time, will observe that the devices introduced by our ancestors, though crude, inefficient, and unreliable, largely preponderate at this late date, and in many cases at mines which are managed by skillful, efficient managers from whom we have a right to expect better things. Reverting again to the subject of trap doors, I may say that I regard them not only as being a source of danger, but likewise a useless, unnecessary expense. Some managers and interested parties have for some time past been seeking ways and means to ventilate their mines on scientific principles, without the use of doors; and with our present knowledge of the science of mining (with past experience for our guide) I see no reason why we should not abolish the much favored trap door wherever it is possible to do so, and I think it can and has been fully demonstrated that new openings and some of our old mines, can be developed, operated and ventilated much more satisfactorily and at less cost without them (especially in the Pittsburg coal bed). Up until the present time our mines, with few exceptions, have been opened and developed upon a system, or systems, requiring a very liberal use of trap doors, consequently we must recognize the fact that in many cases under the best management it will be impracticable to dispense with trap doors altogether, but in such cases we must accept them as a necessary evil, which must be tolerated for an indefinite period of time, and their presence will be a standing rebuke to remind us of our past shortsightedness and imperfect acquaintance with proper scientific methods of mining and ventilation of coal fields, which nature has so abundantly deposited for our benefit and well being. In Fig. 1 is shown one of the prevailing double entry systems of mining and ventilating with room turned on each entry, wherein a liberal use of doors is necessary to conduct the air current forward to the face of the workings, and you will observe that when one or more of those doors are open the ventilation is entirely disarranged for the time being, and, as they are all open many times during the day, it can be readily seen that constant flow of air through the workings is next to impossible, for no sooner is the current re-established by the closing of one door than it is again interrupted by the opening of another one. There is also another system of ventilation in vogue in some localities much less satisfactory even than the one before mentioned; in this case single entries are driven and rooms are opened on each side of the entry, doors being placed on every room neck on one side of entry. The evil effects of this system are so apparent as to need no comment at this time, but this system is now almost unknown in the Pittsburg region. Fig. 2 represents a plan of ventilation on the treble entry system, rooms being worked on the two outside entries only; by this method a large number of men can be employed and an abundant and constant supply of fresh air can be furnished to all working parts, without the use of any door whatever and in case of an emergency occurring in any section of the mine, such as a sudden inflow of gas, an additional amount of air direct from the inlet can be diverted at will to any section where required. This system has been adopted in several mines in Allegheny county and will in all probability be introduced at other mines in the near future. The sketch itself will show the merits of this mode of operation and ventilation. I think it can and has been clearly demonstrated that, by the adoption of this method of development, the expense to the operator is considerably reduced, the miners work in a pure atmosphere and the mine manager need have no anxiety for fear of the evil consequences which may result from trap doors being left open or broken down. I may further say that I incline to the opinion that the treble entry system can be profitably applied in almost any territory (with the possible exception of very thin coal seams not generating explosive gas) but it can probably be used to the best advantage where the coal seam is not less than about four feet thick and not much broken by outcropping lines.

In the discussion which followed the reading of the paper Mr. Blick stated that the three entry system, aside from the question of safety to the miners, would enable the operators to mine about 55 feet of coal more than can be reached by the ordinary double entry system.

THE JUMBO AUGER.

An Improved Drill That Prevents Blown out Shots, and Reduces the Amount of Slack.

A bright and intelligent miner of Blue Rapids, Kansas, who appreciated the advantages that can be gained by increasing the diameter of a shot hole at the back, has invented a practical tool that will bore a large hole back of a small one as easily and with as much certainty, as a small hole can be bored in the bottom of a larger one.

This apparent mechanical impossibility is accomplished by the "Jumbo" Auger which is manufactured by the Hill-Fowler Manufacturing Company, of Blue Rapids, Kansas.

All miners will at once appreciate the advantage of being able to place their powder in a large compact mass in the bottom of a small, deep hole. The most effective blast is the one in which the tamping does not spring and which breaks from the very bottom. This result is made possible by the Jumbo auger. It bottles up the charge behind solid shoulders that never give way until the material in front is moved. It is the unequalled record of the "Jumbo" that out of the countless shots put in with the thousands of these up-to-date drills now in use throughout the West, not one blown out has yet been reported. When there are no "blow-outs" the powder is doing its work and all flame is stifled behind the mass of material that is moved, and the possibilities of dust and gas explosions are reduced to a minimum.

Another important improvement that the Jumbo auger effects is that it enables the miner to place the powder in a compact charge at the exact spot where it will do the most good and where it will move the most coal with the least breakage. From actual tests and experiments it has been found that by using the Jumbo, instead of a common drill, the percentage of slack is reduced more than one-half. It is strictly a lump coal maker.

When the Government recently chose the bottle-necked cartridge with a very large powder chamber back of a 30 calibre bullet, it adopted the same principle that makes the Jumbo shot so remarkably effective.

The "Jumbo" is a powder saver because it makes one pound of explosive do the work heretofore done by two, by concentrating it at the very bottom of the hole where the explosion should take place. It can be used in any mine where twist or rotating drills are used and it is guaranteed by its makers to do its work perfectly and without failure. It takes no longer to bore a hole with it than it does with an old-style bit. It is simple in construction, being made of a single piece of steel. It has neither springs, levers, nor loose parts, and it is practically unbreakable. It is self-cleaning, in up or down holes in either wet or dry coal. It is sharpened the same as other drills and will wear as long. It can be fitted to any rotating machine and operates equally well with air, electric or hand power. It is guaranteed to automatically bore a 4½" powder chamber back of a 2¼" hole, or in like proportion larger or smaller, to any depth, in coal, clay, salt, gypsum or any other material in which augers can be used. It is patented in the United States and foreign countries and all rights will be maintained.

The augers are made in the following common sizes: 6′ auger to bore a 3″ hole back of a 2″; 8′ auger to bore a 3″ hole back of a 2″; 8′ auger to bore a 4½″ hole back of a 2½″, and other sizes to order.

To sum up, the Jumbo auger drill possesses these points of superiority: Safety, effectiveness, simplicity, durability, cheapness, economy of labor, increase of lump coal, lessens the amount of slack, economy of explosives, halving the cost of mining.

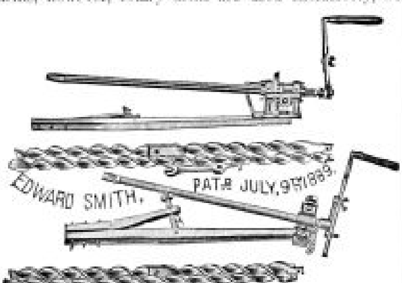
We do not hesitate to recommend all mine workers, operators and owners to investigate the merits of the Jumbo auger, which seems destined to work almost a complete revolution in the methods of drilling, charging and shooting coal and all other soft minerals. To the mine worker it will bring a larger income by increasing his output of coal for powder used and labor expended. To the mine owner it will save the loss entailed by disastrous explosions, besides lessening the amount of slack and increasing the amount of lump coal.

The Edw. Smith Coal Drills.

In no class of work is the difference in results between the older and newer patterns of tools more noticeable than in coal drills.

A case has recently come to our notice where an experienced miner with a knowledge of the ability of modern tools and methods of mining took charge of a mine abandoned some years ago as unprofitable and worthless, and has developed same into a handsomely paying proposition.

About 100 miners are regularly employed, and all are making good wages and prospering. Instead of hand drills, however, rotary drills are used exclusively, we



are informed, and the output per man is far above what it could be with jumper or churn drills. The seam worked is only 36 inches in height.

What has been done in one case can undoubtedly be done in others if proper attention be given the matter. In any case it is worth the while of every miner to get the best tools obtainable and make the greatest output possible. One rotary drill which has been well received in the anthracite districts where it has been used, is that illustrated herewith. It is made by Edw. Smith, Plymouth, Pa., and it will be advantageous to miners and operators to send to the maker for circulars, prices, etc. The advertisement of these drills will be found on page xxix of this issue.

COAL HANDLING.

A Description of the Hauling and Dumping Plant at Pikeville, Tenn.

BY J. J. ORMSBEE.

(Read at the meeting of the Engineers' Association of the South, March 9, 1895.)

In the early days of coal mining in this state the main idea seems to have been to get the output of the mines into the cars for shipment, regardless of everything else. It was all coal, whether lump or slack, so what matter if a car of lump contained a large percentage of slack, due to rough treatment after screening? If there were objections made to this fine stuff, the miner's profits were large enough for him to allow a rebate on it. Tipples then were considered the better, as their costs were lower. A bar screen and a steep chute constituted the typical structure, so built that the coal had a clear drop of several feet from the chute to the car. With increasing competition came demand for a better article. More especially was this true of such coals as those marketed from the Sewanee seam, soft and easily broken in handling and shipping. This, coupled with the poor demand for coke, generally made from slack in this district, determined the erection at the mines of the Sequachee Valley Coal and Coke Company, some two miles above Pikeville, of a plant that was designed to handle the coal tenderly at all points and to clean it thoroughly.

The average elevation of the Sewanee seam in this vicinity is 1,480 feet above tide; but the mouth of the entry is at 1,451, in order to win certain areas of low coal that were revealed by the preliminary drilling. The elevation of the railroad at the site for the chute is but 1,386 feet, and to attain this height required a grade of 4.05 per cent. The difference of sixty-five feet between mine track and railroad was too great for the coal to be conveyed by a simple chute extending from one level to the other. Such a plan would have resulted in serious damage to the product. As power would be required in any case for the proper screening, it was decided to make the lump at a point near the level of the railroad and to elevate the nut and the slack, separating them above their respective bins.

The cars from the mine are taken from the bank level to a trestle, twenty-five feet above the railroad, by an incline with a grade of thirty-four feet to the hundred. In place of a rope a creeper chain is used, carrying thirteen "dogs," that lower the loaded cars and push up the empties, the operating power being furnished by the excess in weight of the loads over the empties. Loaded cars average 2,200 pounds gross; empties, 585. A five-eighths inch Dodge chain with wearing blocks, six inch pitch, is used, working around two sprocket wheels at the top and bottom. To the shaft of one of the top wheels is attached a flange pulley with lever band-brake. At the bottom is a take up, with a play of twenty-four inches. The chain works in a trough. The great advantage of the chain over a rope lies in its automatic action. The cars detach themselves from the "dogs," the empties running to a position where the trips for the mine mules are made up, the loaded cars running some fifty feet out on the trestle to a switch-back, from whence they run to the tippler.

This is of the back tumbler variety, the advantages over the ordinary front tipping type being the reduction of the distance through which the coal falls and the fact that the coal is checked by its delivery against the slope of the short chute just above the screens, and hence is not shot upon the screens with damaging force. The car, when emptied, returns to its horizontal position, a foot lever releases the catches, and the car runs forward from the tippler to the foot of the chain, ready for the next "dog" to start it up.

The chute beneath the tippler is divided by a partition directing the coal to each of a pair of shaking screens, over which is made the lump coal. The screens are each 28 inches wide, 12 feet long, made of No. 8 steel, with circular perforations 1½ inches in diameter. Their slope is but 1¼ in 12, or about 7½ degrees. They are actuated by two eccentrics set at 180 degrees from each other on the same shaft. The throw is 6 inches, and the speed for full capacity, 130 strokes per minute. These screens were first hung by springs of 5-16x2½ inch flat steel, three on a side, the two screens being kept apart by buffer irons. The springs were used with the idea of reducing the shock at the end of the vibrations; but they soon broke and, as an experiment, were replaced by chains. The only alteration required was the placing of guides to prevent the "wobbling" of the screens, and the results have been so satisfactory that it is probable the chains will be used permanently. They have an advantage over the rigid connection in that the inclination of the screens can be changed easily and quickly at any time.

The lump coal passes from the screens to the lump coal chute, which is steel lined and has an inclination of 23½ degrees. On such a slope, with a good steel lining, this coal will just slide slowly. The nose of this sliding chute acts as a door to hold the coal. When the chute is full, the sliding chute is lowered by means of a hand wheel working a rack and pinion, the gate at the nose drawn up, and the coal delivered into the railroad car without having had anywhere a direct drop of more than a few inches. Counterweights render easy the return of the sliding chute to its place ready for another load. As a result of this careful handling and thorough screening, the lump coal loaded at this plant is remarkably free from slack, and has elicited favorable comment from those acquainted with the appearance of lump coal, as usually shipped from the Sewanee seam.

The coal passing through the apertures in the lump screens runs to the foot of a flight conveyor, whereby it is raised and delivered to a pair of shaking screens. This conveyor rises 7¼ inches to the foot, is made of sheets of No. 10 steel, 11 inches wide at the bottom, with flaring sides. Flights are 6x18 inches, fitting the trough, and set 18 inches apart on a ½ inch Dodge chain.

The upper screens are 14 feet in length, with ½ inch circular perforations. The sheets are corrugated. These corrugations run across the screen, are 1 inch high, and 6 inches apart from crown to crown. Their purpose is to check the coal and give every chance for the complete separation of the slack from the nut. The inclination was at first 15 degrees, afterwards reduced to about 12, the nut not being as clean as desired when using the steeper slope. These screens are in other respects similar to those already described. The nut and slack are stored in the bins over the railroad.

The power for operating the plant is furnished by a 15 horse-power 8″x10″ engine, supplied with steam from a slack-fired boiler of locomotive type rated at 30 horse-power.

The nut coal makes an excellent steam fuel, and the slack, on account of its uniform fineness, a strong, solid coke that will bear a heavy burden. This slack makes fully as good coke as disintegrated coal, except for the amount of ash, which is naturally somewhat higher in the screenings than it would be in disintegrated run of mines coal.

The perforated metal shaking screens not only make a clean article, but help the mine in another way—that of increasing the percentage of salable coal. Bar screens allow many large, but flat and thin, pieces of coal to go through the openings, while with the perforated screens, only pieces that will pass through a one and a half inch ring are lost from the lump coal. Nor does the consumer object to this in the least, since, although there are more small lumps, there is practically no slack at all.

The whole plant, so far as the work yet done may be taken as a guide, has fulfilled expectations. It is designed for a capacity of 1,000 tons per day of 10 hours, but has never been tried with anything like that quantity, as regular work in the mines has not begun. Judging from the trial runs it should have no difficulty in handling that amount.

The first cost, including ties, rails, and grading for incline, as well as grading for the bins and trestle, all timber, bolts, nails, machinery, and other supplies, and labor of erection, was $4,400. In regular running, five men and a boy should do the work from the mouth of the mine to the railroad car, at a daily cost, say, of $6. This would give a low cost per ton for handling, even with a moderate output.

FIRE-DAMP.

EXPERIENCES OF A MINE MANAGER

In Some of the Gaseous Mines in the Connellsville, Pennsylvania, Region, With Deductions Drawn From the Same.

BY F. C. KEIGHLEY, UNIONTOWN, PA.

(Read before Ohio Institute Mining Engineers.)

By the term "Mines which generate fire-damp" I mean those mines containing light carburetted hydrogen gas, no matter whether it may issue from the coal itself, the floor, the roof, from clay veins, from faults or by the reason of the presence of fissures in the strata. I do not wish to lead you to believe that mines containing fire-damp are more dangerous than other mines, for such is not necessarily the case. In fact I am going to try and demonstrate to you from my own experience and observations, that the known presence of fire-damp in a mine is not so much to be feared as the apparent and oftentimes presumed absence of it. It is not so much a question of fire-damp as it is a question of conditions, and it is the failure to properly weigh these conditions and the inability or in some cases, the neglect, to make timely and adequate provisions for them that brings disaster. Fire-damp of itself never caused an accident, but conditions neglected or conditions not foreseen, in conjunction with fire-damp do at times result in the destruction of either life or property and often both. Allow me to use an observation of every day life for an illustration of the point I now wish to make and impress upon you. A month ago I was away on a business trip and I went part of the way by boat. Whilst on that boat I saw the usual notice that the owners of the boat had complied with the law. The boat, its machinery, its various attachments and appliances were of the kind and to all appearances just in the condition the law called for. I further read a certificate of inspection from which I learned that the boilers of the boat were allowed to carry a pressure of 160 pounds to the square inch. My stateroom was right over these boilers. Right under me, whilst I slept, a terrible and deadly force was in existence, yet neither I nor any other person could with reason say that that boat was dangerous or unsafe; on the other hand I was perfectly satisfied it was safe. Why? Because the conditions were such that they made it safe. There was the guarantee of reasonable safety. Those boilers were of first-class workmanship. The material was the finest of steel, of sufficient thickness, rivet holes drilled, longitudinal seams double rivetted, flues properly spaced and designed, the diameter of the boilers in proper proportion and the boilers were furnished with safety valves of an area that was sufficient to carry off any excessive force or pressure and the whole was in charge of competent men. This is but one example of the numerous dangerous forces man makes his most powerful levers and best servants, that the traveling public come in contact with every day, and with all of them there is a reasonable, though perhaps not an absolute assurance of safety. Now again let me take a figure for an illustration (I am tempted to say a parallel case) a coal mine that I am perfectly familiar with. This is a shaft mine over four hundred feet in perpendicular depth. In that mine fire-damp made its appearance the second day after the coal was cut in turning off the first heading or entry, and from that day until this fire-damp has incessantly issued from the coal, the roof and the floor. At times the fire-damp was so strong that the men were kept out until it could be controlled; at other times blowers were struck that roared and hissed like escaping steam from a boiler, and at other times the fire-damp has silently filled up the headings in one hour's time a distance of 500 feet horizontally. This mine has been opened up two years and produced 415,000 tons of coal, and during those two years a terrific and deadly power has incessantly manifested itself, yet the first accident and first damage to life or property in that mine is yet to take place. With all this seeming evidence of safety and the non-appearance of disaster, can we justly say that mine is a dangerous one? I say no. Not any more so than we could condemn that steamboat as dangerous, and if I were to decide which was the best risk I would say that coal mine was a better risk than the boat. Now why has that coal mine been safe and why is it still safe? I say simply because the element of danger was known from the beginning, and the conditions being known, they were carefully weighed, understood and provided for. It is not the sandbar marked with a buoy or the rock lying under the gleam of the lighthouse and designated on the chart that brings disaster and death to the mariner, but it is the unknown, the hidden rock that sinks his vessel before he even has time to recognize danger and lift a hand to port his helm.

So it is in the mines, the recognized dangers do not necessarily bring disaster, for they are accepted as the conditions to which that mine is subject and a competent conscientious management endeavors to anticipate these, and when he or they once know them, they boldly and unhesitatingly grapple with them and strain every nerve to conquer and control them. Now I am not going to say that with proper care and skillful management accidents from fire-damp can be made impossible, for from the first breath we draw, we all know that death is ever ready to lay his clammy hand on us, and there is no such a thing as perfect safety in this world, but I will say that many accidents could have been prevented and possible ones may yet be prevented.

I am not going to spin before you to-day any of those beautiful, glittering and startling theories that throw around the science of mining a halo of romance and mystery. I am going to give you good plain horse sense, or in other words, instead of theorizing, it is my intention to reason—to endeavor to deduce from what has actually occurred (in my own experience and under my own observation) in the mines I am familiar with, what could have been done and what it is reasonable to expect or presumed can be done.

The first accident I will cite was the explosion at the Uniondale mine, Dunbar, Fayette county, Pa., some nine or ten years ago. Before I go any further let me say in this particular case my acquaintanceship did not begin until some four or five years after the accident, but that accident or explosion was the means of furnishing me with the biggest tussle I ever had with fire-damp in my life, and in that way I became quite familiar with that mine and the details and causes of the accident. I took out of the abandoned workings of that mine three and one-half million cubic feet of fire-damp, but as that proceeding would furnish abundant material for a paper of itself I must pass over it. The Uniondale mine was opened up on the crude system or methods in vogue in the Connellsville coke region twenty years ago. This mine was not an extensive one, neither was it what might be termed a fiery one. It was a slope mine. The slope being driven on the dip of the coal, the tendency would be for that slope to drain off, to a great extent, the little fire-damp in the coal, if there was any. Adjoining the Uniondale mine were the very extensive mines of a well known iron company and large areas of waste workings from these mines existed about the Uniondale mine boundaries. These waste workings were filled with fire-damp. It is said that one of the operators had trespassed, or in other words, had overrun the boundaries, which one, it is neither my purpose or desire to decide or even intimate; however, let it be either one, the consequence of that trespass was that one day a miner in the Uniondale mine suddenly struck through into those waste workings. The hole was a small one and the miner's naked lamp at that time gave no evidence of the presence of fire-damp. Without closing the hole thus made the miner left it to inform the mine boss of what had taken place, and I am informed that this man told the mine boss that there was no fire-damp there. The man and mine boss went down to the hole with naked lights and an explosion took place, burning them both severely but not fatally. This explosion put out the lights of other miners working in other parts of the mine. After some time one of the miners whose light had been thus extinguished became anxious to ascertain what had happened and he crawled in the dark out onto the slope and there struck a match, and a violent explosion took place, killing —— men and burning others. Now what was the cause of that accident? It is plain that fire-damp was the power that dealt the blow, but it was no more to blame for the accident than the pistol in the hands of an assassin. It was a clear case of conditions not anticipated, or if anticipated that were not provided for. Now what have we? The following facts, viz.: First, that one of the parties had trespassed. Second, that accurate surveys had not been made, or if made, either the matter had been kept secret or some one failed to notice that a trespass had been committed. This, then, was the real cause of the accident—unknown or neglected conditions. It is plain fire-damp was not guilty in this case. What could have been done? The party making the trespass could have had accurate surveys made and thus avoided a trespass, or if the trespass had been known to him or they, notice could and should have been given the other party of the danger. The party driving towards the abandoned workings could have kept bore holes in advance of him. He could have used safety lamps when he found that he was approaching waste workings. The miner should have immediately stopped up the hole he cut, with his hat, coat or shirt and not returned to the hole until notice had been given to the other miners. The mine boss should have scented danger when informed of the holing through and provided himself with a safety lamp before approaching the vicinity of the breach. Had any of these things been done the fire-damp would in all probability never have been ignited.

The second accident I take up for illustration is the Hill Farm mine disaster. This mine also was a slope opened up years ago (perhaps twenty years or more), when a hole in the ground and a pair of broken winded hoisting engines constituted a coal mine.

It, like other mines opened up in the Connellsville coke region ten, fifteen and twenty years ago, was headed into the coal (though occasionally t'other end went first) with nothing definite in view but the chopping out of coal in some way, cheap if possible, but coal in some way if not cheap. The only difference between headings and rooms was that one had an iron track in it sometimes and the other had a wooden one. This state of affairs existed for years, and though at times some fire-damp had been seen, yet for some time previous to the fire or so-called explosion, little if any had been detected in the workings—in short, it was not considered a fiery mine and both naked lamps and safety lamps were in use. After this mine had been worked many years and became an elephant on the hands of the owners a change was made in the management. The new manager was an able man and quick to see that radical changes were necessary—too many to make in a short time; however, to my own knowledge, he took the matter up in good earnest, and one of the first things done was to bore a hole to take care of the water with which the mine was greatly troubled and another hole was to have been bored (it has since been done) in order to get rid of the steam line on the slope. I will here state that I have known the temperature on that slope to reach 140° Fahrenheit whilst the steam line was in use, so you can readily understand why the new management commenced improvement in that direction first. When the first bore hole (or water hole) went down, it struck a point in the coal seam 11 feet from the slope. The hole was completed on Friday but not tapped until the following Monday.

At 11 o'clock of the morning of the fatal day, the miner's pick struck into the hole and the water contained in the hole rushed out with terrific force and a loud roar. The man working there escaped and his naked lamp did not fire the gas. A few minutes later a boy some distance up the slope, with a naked light on his head, heard the terrible uproar, and laboring under the impression that water had broken into the mine, rushed down the slope to warn the miners below. In passing the bore hole he ignited a blower of fire-damp that came out of the bore hole. This blower shot out a long finger of flame that reached out across the slope to the bratticing and that bratticing took fire. At this stage of the fire it might have easily been checked by the tearing down and trampling of the brattice cloth, but it was either not thought of or perhaps overlooked in the confusion and the flames at once began to play upon a trip of loaded cars standing on the slope. These cars were saturated with oil and, standing right on the main air return, they so constricted the air passage that a high velocity was reached and this fanned the flames with frightful vigor and in a very few minutes the whole of that part of the slope was a seething mass of flames and dense smoke. Twenty-nine men were cut off from retreat by that fiery barrier and two more brave fellows lost their lives by attempting to force their way through the smoke to their comrades and if possible save them.

Thirty-one persons lost their lives by that fire, not by explosion as commonly reported at the time, but through their inability to pass that fiery barrier. They were hemmed in there until suffocated by the fumes. Now what are the facts in the case? Did fire-damp kill those men? I say no. It was the conditions prevailing at the time that did the work. Fire-damp was the arrow and conditions the bow that drove it forward on its deadly errand. Need that arrow to have left the bow? I say no, if the conditions had been anticipated and provided for. Could these conditions have been foreseen? Could the deadly combination of circumstances have been prevented? It would seem upon reflection that they could have been. The hole could have been tapped Saturday evening or Sunday. Failing to tap it then the men could have been withdrawn on Monday and kept out until the tapping had been done. It might have been tapped in working hours with a reasonable degree of safety if nothing but safety lamps had been used for lights and a small bore hole kept a short distance in advance of the workmen. If the mine had been properly opened up and had a manway on each side of the slope or a brick overcast been built to connect both sides of the workings with the manway in existence at that time, the fire could have burned with the greatest violence and still not a man have been lost. It was not the fire of itself that killed the men, but the fact that the fire was in the only avenue of escape. It was a barrier with death on the one side and life on the other—those men were on the side of death. Years before that fire took place the death trap had been unconsciously set. It was the advance into the coal field with no route for retreat. The bridge to carry them back in and to safety was not destroyed. It was never built. Let every man today who is in the act of planning or opening up a new mine, long reflect and be sure that he is not setting a trap that will some day close its relentless jaws upon those who were not only not responsible for it, but who never suspected its existence. Opening up a new mine is a serious undertaking and the plans need to be skillfully drawn, deeply studied and carefully carried out if found to be drawn on safe and correct lines. The question will be asked, Why was that bore hole opened in the manner and at the time it was? To this I will say that I presume it was because the management anticipated no dangers, as bore holes had been tapped in a similar manner before without mishap. I am satisfied that if the management installed shortly before the time of the accident had had the planning and management five years prior to the date of accident, no such a deadly combination of conditions could have taken place, for Mr. Hill would never have tolerated such slipshod work as that which ruined that mine. Mr. Hill was not captain until the ship was a dismasted hulk, with a demoralized crew, and he had to run before the gale, not as he would, but as he could.

Now I cannot tell you all my experiences in the coke region unless I monopolize the whole of the various sessions, so I will take up only one more mine that I know. That mine will be the Mammoth mine. From what I experienced there I will conscientiously endeavor to point out the lessons to be learned from that terrible disaster. I say lesson because every accident reveals to all of us something we did not know and understand before, and the mining law of the state of Pennsylvania has reached its present efficiency by the means of accidents, each of which traced with its bloody finger the deficient clauses. The "Mammoth Mine Disaster" was in all probability the result of the ignition of fire-damp by a naked light. This fire-damp suddenly and unexpectedly gathered in the rib or pillar workings and in all probability it issued immediately after the fire boss made his examination from the strata underlying the coal and not from overlying strata. Previous to the explosion the Mammoth mines had always been remarkably free from fire-damp and open lights had always been used in all parts of the mines. I say mines because there were two openings—a slope and a shaft with hoisting engines at each opening. I had taken charge of the Mammoth mines a little over two months before the explosion and up to the day of the explosion I never carried anything but a naked light, as all others did, with the exception of the fire bosses, who in their daily morning examinations, of course, used the Davy safety lamp. I had traveled over the whole of that mine in company with the mine boss with nothing but naked lights, but of course never until after the fire bosses had had made their morning examination. During that time I never either saw or heard of fire-damp being found. When I went there first I asked the mine boss, assistant mine boss and the fire boss if they had seen any fire-damp in those mines. They said not, with the exception of a couple of small blowers that were struck when the shaft was first opened up years before and which were long ago exhausted. The mine I had last had charge of, before going to the Mammoth, was a very fiery one and it was worked with safety lamps. Being accustomed to the use of safety lamps I looked upon naked lights at first with some distrust, but learning that naked lights had always been used there and being assured by all and by my own observations that fire-damp did not exist in the workings and also knowing that the mine inspector had not said anything about exclusion of naked lamps, I saw no reason for comment on my part. My first intimation of danger was the explosion itself. On the morning of the disaster, not more than ten minutes before the blast came, I went into the engine house and examined the fire bosses report and found it signed as usual, with no remarks on its face beyond that the mine had been examined at such an hour that morning and found to be safe. After reading the report I put it back in the desk and was about to ask the engineer for a cage when I learned from him that there had been a wreck on the trestle leading to the coke ovens. I at once went to see what had caused the wreck and whilst standing within twenty feet from the shaft I was startled by a rumbling noise and looked up in surprise, to see a vast cloud of smoke hanging over the derrick like a huge balloon. I at once got down off the trestle and ran to the fire-pump and got it started and the water turned down the shaft, expecting to see flames next, but none came, so in about five minutes we stopped the pump for no flames showed up. We next started the cages to running and two men and a boy came up. They could tell us nothing, though all were uninjured, so I at once called for volunteers and together with two others (all that answered the call) I went down the shaft and found all the stoppings and doors blown down. Could not find a soul, so went to the top of the shaft for more help and boards, nails, etc. In a few minutes I went down again with the mine boss and some others to start bratticing and exploring, and a short distance from the bottom of the shaft we found six Hungarians from the slope workings alive and uninjured. These we sent out and proceeded with the bratticing and exploring and from that time forward we found nothing but destruction and dead bodies. One hundred and nine men had died in a few minutes time for the want of air. Of the forty-six bodies I personally helped to remove not one was mutilated and I understood from the other explorers that only two or three of the remaining sixty-three bodies were mutilated, so it would seem that all or nearly all died from the effects of after-damp. The cause for all this very great loss of life was undoubtedly the blowing away of the main door and stoppings. The air after the explosion simply went down one compartment of the shaft and up the other until the bratticing was replaced, which was of course the work of many hours' time, although we did manage to reach the first bodies in less than three hours' time. Had the mine been properly laid out without doors at the very base of the intake, and been ventilated by means of split air currents and overcasts, as it should have been, and as I planned but the day before the explosion, very few, if any, would have lost their lives. I had just completed a new ventilation plan for the mine the afternoon before the explosion. With the old system of ventilation the opening of one door near the foot of the shaft on the inclined plane where all our coal was hoisted to the foot of the shaft, cut off all air to the shaft mine workings. Of course that door was opened and shut for every trip of loaded cars hoisted and every trip of empties run down, and in case of a wreck that door would have to remain open.

Now what do we learn from this outline of that accident? First we find, as in the other cases cited, that there was a sudden and unexpected influx of gases. Could this sudden influx have been foreseen? I think it is doubtful in this case for the reason that only since the few days following the accident (it is now three years since it happened) has fire-damp been detected in that mine and then it was a sudden outburst lasting but a few hours. This time no naked lights were in use, so it was not ignited. Could the ignition of fire-damp have been prevented? It could in all probability if naked lights had been excluded; however, it is a difficult matter to determine just where safety lamps should be installed, and after my experience I would not wait for the appearance of fire-damp. I would favor the use of safety lamps from the beginning of the mine for it is an uphill business to introduce them and educate the miners after naked lights have once been used in a mine. This I know as I introduced or installed them at two mines and it was a bitter fight in each case. Even at Mammoth, after all the loss of life, it was no easy matter to get the men to look upon the safety lamp with favor.

A careful examination of the mine by many experts seemed to warrant the presumption that in this case the fire-damp came from the floor of the mine, which is a rather unusual circumstance in the Connellsville coke region, though I do know of another case where a sudden outburst of fire-damp came from the floor of one of the largest mines in the coke region, whilst the fire bosses were just completing their morning examination, preparatory to the lowering of the men into the mine. It was so sudden and of such violence that the fire bosses had to hasten to the top of the shaft by way of the cage and the fire-damp reached the surface as soon as they did. It took three days' work with a constant supply of 100,000 cubic feet of air per minute in circulation to control that outburst. I will here say that there was some disposition on the part of the public to charge neglect on the part of the fire boss making the examination at the Mammoth mines. Now I can hardly think that a fire boss would deliberately report the mine safe if he found it otherwise, go out to breakfast, then return to the mine without saying a word, to face a violent death, which he did. The fire boss died at his post and met it in one of the most remote headings of the mine, the lowest flat heading below water level. I knew the man intimately and I never met a more able man in his line or calling, in fact I had such a high opinion of him that I intended to make a mine boss of him at my first opportunity.

In the Mammoth mine disaster you again see the dreadful consequences of unforeseen conditions and the appalling results from the faulty planning and opening up of a mine. You will ask why did not the owners of the mine see that the mine was properly opened up? Let me say that the owners at the time of the accident were not responsible for its faulty development. They bought the mine years after it was opened and from the day they bought it until this very day it has been a continual succession of improvements. I was only there myself eleven months, yet during that time I used over 200,000 red brick for overcasts and stoppings alone. A mine spoiled in the beginning is a ticklish thing to handle,and it takes years of incessant study, labor and expense to right its wrongs, and in the case of some mines I know, the damage from poor planning and working is absolutely irreparable. Such mines as those wear out the very soul of the man in charge and an ordinary man can fight but one such battle in his lifetime, for by the time he gets a wrecked mine in shape he has become a wreck himself. Again let me say to those opening up or about to open up new mines, be careful and plan with skill, for as the twig is bent so the tree will grow.

Perhaps some of you would like to know what kind of a mine I would like to handle. I will tell you. I will take the gaseous mine every time. I want no more of your presumed absolutely non-gaseous mines. With the gaseous mine I know the danger and I know how to fight it. The miners know the danger and they are observant, careful and ever keenly alive to the existence and treachery of the enemy and it never catches them sleeping in fancied security. With the non-gaseous—that is the presumed non-gaseous mines—everything is happy go lucky; the naked light hob-nobs with the flaming petroleum torch, and the overflowing odoriferous petroleum can kicks up its heels and follows in the procession that revels in the very presence of death, and lights the ghastly horrifying pyre. The new mining law of Pennsylvania sits down heavily on the funeral torch that feeds on petroleum, and I am glad that it does, for of all the fights I ever had in my life, the fight against petroleum in the mines was the most bitter and hard.

I suppose that as I have expressed a desire for a fiery mine, you will next ask how I would open up my fiery pet. In answer I will say with three shafts, and with two, three, four and five headings, as the circumstances and conditions might demand or make justifiable. With heavy shaft and heading pillars, the division of the mine into sections—each section protected with heavy barrier pillars; no cut throughs in the barrier pillars excepting at section intersections; with split air currents; the exclusion of naked lights; fans in the duplicate; one shaft for return exclusively, shafts sunk as far apart as possible under the circumstances; concentration of working forces; drive the headings away ahead of immediate requirements; adopt rope haulage and aim for a large output.

MINE SURVEYING.

The Importance and Value of Accurate Mine Maps.

BY WILLIAM HIBBS.

(From Transactions of the Ohio Institute of Mining Engineers.)

This is a very common subject to many people, but the fact of its being common is like many other things that are conducted in old and narrow channels and for years and years make no change in their form or usefulness, until necessity or common sense, the mother of all invention, leads them out in a new way to improvement. Ninety-two years ago the surveyors laid out this part of our grand state into sections and quarter sections. They followed the magnetic needle through the dense forests from sun-rise to sun-set. Since that time the county surveyors have hunted for those lines and divided those quarters while the magnet varied from hour to hour, sometimes knowing they were right but frequently allowing a very wild guess.

With the mining engineer the case is different. He has long since departed from the guidance of the needle. He has a different *modus operandi* in a different place; a different work for a different purpose. And let me say just here, that it is not my desire to write of other states, but as to Ohio, a great amount of its mine surveys are not creditable to the profession. County surveyors and railroad engineers have no love for the miners and little affinity for the mines. This accounts for the fact that so much mine work is done in a careless and indifferent way, and when the work is platted upon the paper in map form, it is inelegant, inconvenient and of little practical benefit except to fulfill the law and to avoid lawsuits. Mine inspectors pay little attention to surveys, and of course many operators regard them as an unnecessary expense. And true, many are such.

The writer has seen a number of mine maps of this class. One in my recollection was drawn with a lead pencil upon manilla paper. All that could be seen was the entries, or rather the stations taken with straight lines drawn from one to the other. The work cost the operator $45, and he said it was not even correct. You need not go outside Jackson county to find this map and the man who made it. Another was platted upon vellum cloth. The work was correct, but several entry lines, which were the only ones shown, extended beyond the edges of the paper. These and a part of the boundary lines and buildings connected were the only things mapped. It cost the owner $230, and if viewed by a stranger it could not be told from a part of the jungles of Africa. This chart was the work of one of the profession in Guernsey county. Many others could be mentioned, but these are sufficient. They belong to the class which may be regarded as an expense; but that expense should yield a profit if the work were rightly done. The value of a good map can hardly be estimated.

A mine map should contain among many other features the following points of interest:

1. The property lines of the territory and parts of the adjoining lands.
2. The approximate crop lines of the property and that of the lands adjoining.
3. The location of all roads, railroads and buildings.
4. The meanderings of all water courses and ravines.
5. The forms of relief of the surface by contours and the elevation of important points inside the mine.
6. The correct form and size of the underground workings.

The surface lines are the first to demand the engineer's attention, and upon them depends not only the shape of the property, but in many cases a division of royalties must be made according to their position. The location of each corner must be made accurately according to the best evidence, the records of the public surveys and the rulings of the Commissioner of the General Land Office.

Each surveyor has his own particular way of doing things, and indeed the measure of an engineer's ability is in his being ready with a plan for anything at any time, and his having the stamina to carry it out. Probably the best way to locate the property lines is to first find one corner. Then from the records take the bearing to the next as nearly as can be calculated by known movements of the needle, being sure there is no magnetic disturbance, and if there is, to turn it off.

After deciding upon this approximate bearing, lift the needle from its pivot and range the line by use of the transit telescope, setting stakes, with tops flush with the ground, at important points and especially at places where a wide view of the surroundings can be taken in the future. No stake should be hid from view from the nearest two. Measure the horizontal distance from the beginning to each stake and also the full length of the required line, setting a stake at the end. From this the second corner can be located. Then take its bearing and distance to it. This new survey can be platted and the two corners located upon the map when a straight line can be drawn from one to the other, thus making the first true line of the survey. In a similar way other lines may be ranged out and the corners located, and when put upon the map, will constitute the property lines, while the different stakes upon them will serve in the future as references in obtaining the location of any point in the true lines.

The crop lines are of much importance, because when rightly traced they show the shape and size and the possible extent of the underground workings, besides they serve as a guide in laying out plans of mining. In surveying them it is well to use a combined transit and leveling instrument. (There are none better than those made by Heller & Brightly, of Philadelphia, Pa.) The start should be at a well known spot where the seam comes to the surface, or at the pit mouth of a drift mine at or above water level. After taking the height of the instrument upon the rod, let it be carried forward to a spot exactly on a level with the point of beginning, when the bearing can be taken from the needle and the distance read from the rod by the stadia wires. Thus will follow one course after another, checking up or down as the case may require at any and all points where the seam can be seen or found conveniently. After following out the croppings through the entire tract and as much more as would be of benefit, and after platting the survey, a number of points will be found on the paper by which the line may be drawn practically correct.

The location of roads, railroads, buildings and water courses may be generally made by taking notes by the use of the stadia wires as the other work proceeds, but when the streams and ravines lay above the underlying strata a careful survey of them must be made, which may be done by starting from a well known datum and by the needle, stadia rod and wires, reading the bearing, distance and elevation of every station along their courses, and at all points where the tops and bottoms of all strata occur, readings should be made, that the elevation and position of the overlying rocks, when platted upon the map, will show to the mine manager where to locate his works in the future. By this he can see at a glance where or in what direction to look for dips and rises, and by the position of the ravines to avoid deluging the mine by letting in some stream of water. Location of faults in some cases may be made when no knowledge of them otherwise exists.

Last but not least, the forms of relief may be considered. This part of the survey can be accomplished in the following manner: By stadia measurement starting upon the former datum and from this and the points whose elevations are known from the former work, take readings for distance, bearings and elevations to all points that may serve in getting the height at different places on the surface. Then extend this work to new points until a network extends over the entire territory. When this is platted, showing position and elevation of all the points, contours may be drawn among them, thus showing the thickness of the overlying strata and the shapes of the hills and valleys.

Much more could be said, but not in this short paper, and the author will cease by saying that the underground works should be traced correctly and extended at convenient periods and mapped in a separate color each time. The levels should also be taken for all inside points, with reference to the surface datum, and marked upon the map in a different color from surface figures.

Thus a mine map may be made that would be of some use to its owner. It would serve him in making his calculations, and if the chart be constructed before he commences his work, it may save him a great unnecessary outlay of capital and labor, for it is always best to know previous to any work, all that is possible to know.

Let an exact copy of this plan be made, divided into convenient sections and numbered and then cut apart. This sectional map can be carried, entire or in parts, into the mine or about the works, where reference to it can be had without the trouble of going to the office and unrolling the large one.

High Grade Coals.

The Berwind-White Coal Mining Co. has received from the officials of the World's Columbian Exposition, a bronze medal and diploma for an exhibit of three sections of typical coal seams, worked by the company. No. 1 section was from Horatio, Pa. It consisted of a section of a steam coal seam 7 ft. 7 in. thick. No. 2 section was from Anita, Pa. It consisted of a section of a steam coal seam 4 ft. 8 in. thick. No. 3 section was from Houtzdale, Pa. It consisted of a section of a steam coal seam 7 ft. thick.

The official analyses of the coal yielded the following results:

	No. 1 Section.	No. 2 Section.	No. 3 Section.
Water	0.954	1.090	0.844
Fixed Carbon	60.861	61.028	73.292
Volatile Matter	30.871	31.865	21.806
Sulphur	1.124	1.012	0.643
Ash	6.160	5.035	3.415
	100.000	100.000	100.000

Climax Boilers Adopted.

The Cloubrock Boiler Co. has contracted to erect 900 H. P. Climax boilers in units of 300 H. P. each for the new steam heat station of the Economy Light, Heat and Power Co., of Scranton. These boilers will be equipped with McClave grates, and will have three independent stacks. They are to be completed by September 1st.

Classification of Coals—Correction.

In the table showing the physical and chemical properties of Standard Connellsville Coke, on page 258 of the June issue, the terms Wet and Dry were transposed. The weights and measures therefore given for dry coke should be for the wet, and *vice versa*.

CORRELATION TABLE,

Coal Measures of Western Pennsylvania Compiled for The Colliery Engineer and Metal Miner by Baird Halberstadt, Mining Geologist, Pottsville, Pa.

Prof. J. D. Dana's Table of Formations.	Table of the Second Geological Survey of Pennsylvania.	Names Provisionally Adopted by Prof. Lesley.	Numbers.	Coal Beds and Their Thicknesses in Each Series.
Upper Coal Measures	Upper Barren Measure 1100 - 1200 ft.	Greene County Group 300 - 400 ft.	XVII	Windy Gap (1′ 0″ — 2′ 0″), Nineveh (1′ 0″), Dunkard (1′ 0″ — 1′ 3″).
		Washington County Group 700 - 800 ft.	XVI	Jollytown (2′ 0″ — 3′ 0″), Washington A (4′ 0″ — 5′ 0″), Washington (5′ 0″ — 8′ 0″). Little Washington (0′ 6″ — 0′ 10″), Waynesburg B (1′ 0″ — 2′ 0″), Waynesburg A (3′ 0″ — 4′ 0″).
	Upper Productive Coal Measure 350 - 450 ft.	Monongahela River Series 350 - 450 ft.	XV	Waynesburg (4′ 0″ — 10′ 0″), Uniontown (3′ 0″), Sewickley (5′ 0″ — 6′ 0″). Redstone (3′ 0″ — 5′ 0″), Pittsburg (4′ 8″ — 10′ 0″).
Lower Coal Measures	Lower Barren Measures 550 - 650 ft.	Barren Measures 550 - 650 ft.	XIV	Little Pittsburg (1′ 0″ — 2′ 0″), Elk Lick or Barton (2′ 0″ — 4′ 0″), Platt or Crinoidal (1′ 0″ — 1′ 8″), Bakerstown or Price (3′ 0″ — 4′ 0″). Masontown or Brush Creek (0′ 6″ — 4′ 0″), Mahoning (1′ 0″ — 3′ 0″).
	Lower Productive Coal Measures 250 - 300 ft.	Allegheny River Series 250 - 300 ft.	XIII	Upper Freeport (E) (1′ 0″ — 6′ 0″), Middle Freeport (D′) (2′ 0″). Lower Freeport (D) (4′ 0″ — 7′ 0″), Upper Kittaning (C′) (0′ 6″ — 3′ 0″). Middle Kittaning (C) (2′ 0″ — 4′ 0″), Lower Kittaning (B) (3′ 0″ — 4′ 0″). Clarion (A′) (3′ 0″ — 5′ 0″), Brookville (A) (4′ 0″ — 5′ 0″).
Millstone Grit	Pottsville Conglomerate 200 - 300 ft.	Pottsville Conglomerate 200 - 300 ft.	XII	Mercer Upper (0′ 4″ — 2′ 6″), Mercer Lower (0′ 8″ — 3′ 1″). Quakertown (1′ 0″ — 2′ 0″), Sharon (1′ 4″ — 4′ 0″).

Easy Lessons on Mining.

This Department contains articles to assist ambitious Miners to educate themselves, and obtain Certificates of Competency as Mine Foremen, or to become Mine Superintendents.

The articles are written to be understood by the unlearned and the learned alike. Plain language is used, no obscure terms are employed, and each subject treated, is made as clear and easy to understand as possible.

Further: The Questions asked at the different Examinations for Mine Foremen and Mine Inspectors, are printed and answered.

☞ The Series of Articles "Chemistry of Mining," "Mining Methods" and "Mining Machinery" was commenced in the issue of March, 1894. Back numbers can be obtained at twenty-five cents per single copy, $1.00 for six copies, and $2.00 for twelve copies.

MINING ARITHMETIC.

Arabic Numerals—Numeration—How to Add Efficiently—Arithmetical Signs.

1. **The Arabic Numerals.**—In this course of lessons, only such instruction will be given in the simple rules as is necessary to draw attention to matters that are too often disregarded by beginners; therefore the student is expected to supplement the exercises that will be given in the four simple rules by examples of his own. Many persons live to regret their former carelessness in not having taken pains to master sufficiently at first the essential elements of the simple rules. We will therefore endeavor to present the facts that ought to be mastered and understood in such a simple way that the study of them will neither weary nor perplex the learner.

Notation or the mode of writing the figures, and *Numeration* or the mode of placing the figures to represent a number, will first have attention, and to clearly distinguish the meanings of the terms notation and numeration, we will reverse the course commonly taken, and begin first with numeration, for it preceded in human experience the practice of notation.

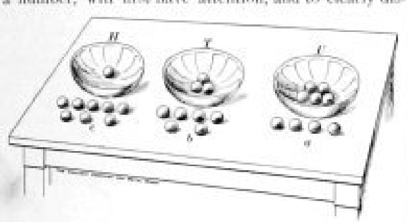


Fig. 1.

The figures in common use are supposed to have originated in Arabia or India, and they were at first only rude pictures of the bowl and pebble system of recording a number, or of numerating a host or multitude of things that could not otherwise be measured. Fig. 1 is an illustration of the ancient way of numerating a multitude of things that were all alike in character and value. The bowl and pebble system here shown was the forerunner of the Greek and Roman abacus and the present day Chinese counting frame, and therefore its use and history is in no sense mythical. Three bowls and three groups of pebbles are shown at *H T U* and *c b a*, and the process of numerating was as follows: *U* was the units bowl and *nine* pebbles were provided for it; for be it observed that a tenth pebble would never be required for it, as ten was represented by one pebble in the second bowl, and just in precisely the same way we now use *nine* figures only and the number *ten* is represented by 10 or 1 set before a cypher. Suppose a pile of apples have to be numerated; then one pebble will have to be put into the units bowl for every single apple up to nine and for the tenth apple the nine pebbles have to be taken out of the *U* bowl, and one put into the *T* bowl, and as ten tens are a hundred, when that number is reached instead of putting the tenth pebble into the *T* bowl nine tens are taken out of the *T* bowl, and one to represent ten tens, or a hundred, is put into the *H* bowl, and in the event of there being more than nine hundreds to numerate a fourth bowl is introduced, with the result that the numeration of the ancients, by the decimal system, was in every respect precisely the same as that practiced by us now. It will be seen that the number numerated by the bowls before us is 135.

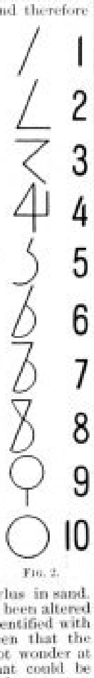


Fig. 2.

Nothing, perhaps, is more interesting than the pictorial system of notation, said to have been invented by an Arabian fisherman, and still practiced by us, and it is for that reason that we here give the figures in Fig. 2, as at first written by this Arabian with a piece of chalk, or with a stylus in sand. Indeed, so little has the form of the figures been altered that the original Arabic numerals can be identified with those we are writing now. It will be seen that the unit figure 1, is not altered, and we cannot wonder at this, because it was the best picture that could be taken to represent it. Two units were set down as two marks, and three as three, and four as four distinctly drawn lines; and by contrasting them with the figures one, two, three and four, as we now write them, they are still recognizable as the same pictures.

Five was a picture of *one*-half of a bowl, and, observe, it consists of half a bowl with a stroke above it, signifying *one*-half; six was half a bowl and one *over*; seven was half a bowl and two over, and eight was half a bowl and three over; nine is the picture of a bowl all but one, and the tail of the figure is the absent one; ten is a picture of the units bowl when empty, and the unit figure is shown at the left of the empty bowl as ready to put into the bowl of tens. The cipher is only a picture of an empty bowl, and therefore the figures our learned men employ for the solution of their grandest problems were at first only the childlike picture writings of a poor, ignorant Arabian fisherman, and, stranger still, the sketches made by this simple man have been copied and repeated again and again by millions of our race, and still the writing of these pictures is repeated. We now see that our notation is made up of nine figures and a cipher, and that by setting the figures in a certain order we can numerate values that otherwise would be incomprehensible.

2. **Numeration.**—To numerate a line of figures they are first divided into groups of threes, and these triplets as they advance to the left, are given different names, as follows:

B M T
123,123,123,123

That is to say this number reads, one hundred and twenty-three billions, one hundred and twenty-three millions, one hundred and twenty three thousands, one hundred and twenty-three.

All figures from and to the left of the unit's place represent concrete or whole things, and all figures at the right of the units place represent parts or fractions of things and being progressively less than one they are numerated as follows: hundreds tens (units), tenths hundredths; for example, numerate 236.543. Two hundred and thirty-six and five hundred and forty-three thousandths. When a point or period is set before a line of figures, the number is always less in value than one thing, because the point represents the end or unit's place of a whole number, and the decimal fraction before us in common with all others that ever can come before us, is easy to enumerate by observing the following simple rule. First, numerate the decimal number as if it was a whole number. Second, suppose the units place is one, and the other figures in the decimal number are ciphers, and then numerate as follows:

.543 five hundred and forty-three,
1000 one-thousandths,

or five hundred and forty-three one-thousandths. Again, .00005 reads five one hundred thousandths, and 27.15 reads twenty-seven and fifteen one-hundredths.

3. **How to Add Efficiently.**—No instruction is required to enable a student to perform the simple operations of addition and subtraction, and it is for this very reason that so many people are so slow and inaccurate in their additions and subtractions, for they believe that speed and accuracy will come with practice; but they do not, and then they conclude that they are not by nature gifted for rapidity in finding the sums and differences of numbers. In this conclusion they are wrong, for by proper training, most men can be made expert at addition and subtraction.

When a student is slow in these operations all his exercises with figures are tedious and fatiguing, and therefore he never becomes a good arithmetician, and for this reason we say to all our readers, if you are inefficient on this score, commence again with the first two simple rules, and follow our advice.

To be expert and reliable then you must first cultivate self reliance and courage; for timidity and hesitancy paralyze the mind and make you a stutterer in figures, and if ever you acquire the habit of inconfidence you can only cast it off by adopting a system of drill such as we are about to recommend.

First exercise in self reliance: Set down the following figures in the order in which we give them.

```
 5 7 9 3 4 7 2 6
 9 6 8 7 7 9 6 5
1 5 4 8 1 2 6 9 1
```

Here we have an exercise in addition in which the sum of the numbers is given, to prevent hesitancy: Drill one: Begin and say five and six are eleven, seven and two are nine, etc., and practice this very simple addition until you can do it with perfect self reliance in a second or two. Then take drill 2:

```
 8 5 9 3 6 8 4 2
 4 7 0 8 7 2 5 6
 5 4 6 7 8 1 8 9
1 8 7 7 0 2 2 8 7
```

and after you find that you can make the addition in about four seconds, make some examples for yourself in drill two; but take care while on this drill, never to make the columns more than three figures deep, and never increase the depth until you are very expert and quite able to trust yourself in attempting a greater effort. The senses of sight, hearing and feeling have all to be cultivated, and therefore it is imperative that at first you speak aloud the additions you are making, and above all you must not hesitate to consider whether the additions are right or wrong in any case, but tear away and remember that *faith* is the secret of success.

The same drill must be practiced with subtraction, and the exercises must be continued until you can trust your own self for accuracy, while your speed is so great that you have not time to *think* and hesitate. Slowness in the operation of multiplication is the result of hesitancy in adding, and slowness in division is the result of hesitancy in adding and subtracting, and therefore we ought to find an immediate cure by submitting ourselves to a proper system of drill.

4. **Arithmetical Signs.**—The use and correct meaning of the arithmetical signs should be understood; in this lesson three of them are introduced. The first is the addition sign, written thus +, and it is called *plus*. The

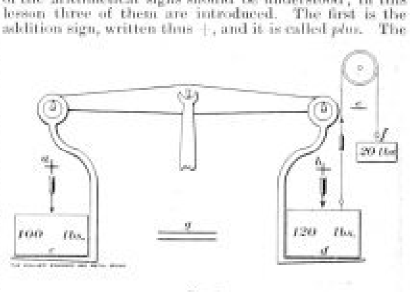


Fig. 3.

second is the sign of subtraction, and it is written thus —, and is known as *minus*. The third is the sign of equality, and is written thus =, and is called *equal to*. The uses of these three signs are exemplified in Fig. 3. Here we see a scale balance in a state of equipoise, and to indicate this condition with clearness, the equality sign *g* is set between the scale pans so as to render the use of the sign unmistakable; for with beginners the trouble is not so much to make them understand what you mean as to make them realize the application of a principle. Now, we have a 100 pounds weight on the *c* pan, and a 120 pounds weight on the *d* pan, and we are sure 100 pounds cannot balance 120 pounds; but a *negative* weight of 20 pounds is made to counteract at *f* the excess of weight on the *d* pan, and therefore the 100 pounds on the *c* pan, after all, only balances its equivalent of 100 pounds. Under these conditions we see the application and use of the signs, for 100 = 120 — 20, or, in words, a 100 pounds weight balances 120 pounds when the excess of 20 pounds is counteracted. If we consider the earth's attraction as a positive pull downwards, then any force acting upward is *negative*, or opposite, to the earth's attraction, or an upward force is negative to the earth's attraction. By introducing the pulley at *e*, 20 pounds at *f* are made to pull the left hand side of the cord upward, as shown by the arrow. Here, then, we see that forces acting downward are positive and those acting upward are negative, or, to be still more clear, if 100 pounds acting positively, or downwards are counteracted by 100 pounds acting negatively, or upward, then *nothing* is equal to one hundred minus one hundred, or 0 = 100 — 100. The plus, or positive sign, is seen at *a* + and *b* +, meaning to say that the weights in the pans *c* and *d* are pulled by the earth, but the negative sign is seen at *e* —, because the weight *d* is pulled upward with a force of 20 pounds.

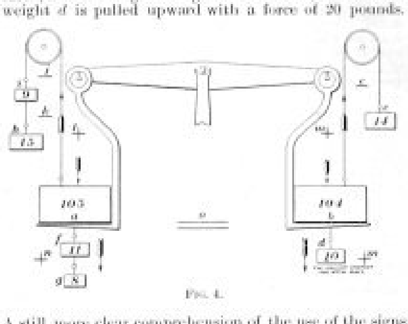


Fig. 4.

A still more clear comprehension of the use of the signs may be obtained by a study of Fig. 4. First, then, let us balance the forces by taking all the downward ones as plus, or positive, and all the upward ones as minus, or negative; then,

$$105 + 11 + 8 - (15 + 9) = 104 + 10 - 14$$

Here the mere downward force on each scale pan is 100 pounds; but before proving this, let us observe the weights *i* and *h*, when it will be noticed that although the force exerted by them is made by the cord and pulley to act negatively to the weights *a*, *f* and *g*, yet *i* and *h* are positive to each other, and it is for this reason that in algebraic equations, we change the positive and negative signs of all the letters within a bracket when the first letter is a negative one; for see, we have written $105 + 11 + 8 - (15 + 9)$, not $105 + 11 + 8 - 15 - 9$. By looking at the figure we see that *i* is positive to *h*, or *i* is acting in the same way as *h* to pull the pan *a* upward, then $15 + 9 = 24$ or $-(15 + 9) = -24$ and we now see that $105 + 11 + 8 - 24 = 100$; and that $104 + 10 - 14 = 100$, therefore the resulting positive force on each of the pans is the same, and $100 = 100$. The terms positive and negative are not confined to forces acting downward and upward but to forces acting in simply *opposite* directions.

In this case positive is downward and therefore *a*, *f*, *g*, *l*, and *d* are +, that is positive or plus, and the forces *i*, *h*, and *e* are −, that is minus or negative forces.

(To be Continued.)

MINING MACHINERY.

The Principle of Action of the Lift Pump—The Pressures on the Valves of a Lift Pump—The Interruptions That Occur in Pump Action—Recapitulation of Facts.

123. **The Principle of Action of the Lift Pump.**—We need not insist upon the importance of miners having a complete knowledge of the mode of action of the common lift pump, for in some form or other it is an indispensable appliance in mine drainage. We never feel so much the value of knowledge as when we are confronted with a difficulty that requires its assistance, as for example, when a pump fails in its action through some disarrangement, and we are expected to diagnose the fault and correct it. Let us, then, in this lesson first notice the mode of action of a lift pump on the upstroke, and to make the subject clearly understandable, let us call to our aid Fig. 155. The pump piston *a* is advancing upward, as indicated by the arrow *g*, and the valve is down on its seat as the result of having the entire weight of the column resting on it. The statement just made is correct, but are we sure that we have the right understanding of what is meant by the words "entire weight of the column"?

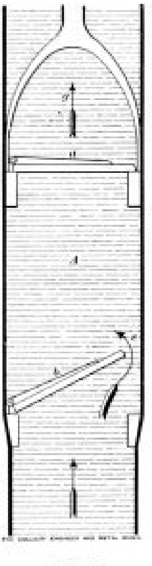


FIG. 155.

124. **The Pressures on the Valves of a Lift Pump.**—Then, let us suppose that in a mine shaft the column of water resting on the pump piston *a* is equal in length to a vertical height of 300 feet, then we may correctly conclude that the "entire weight of the column" will be equal to $300 \times 62.4 = 18{,}660$ pounds, or $\frac{18{,}660}{2{,}000} =$ 9.33 tons, assuming that the area of the pump piston is 1 square foot; or if it is not, then we may say that the *pressure* on the pump piston is in the *proportion* of 9.33 tons per square foot. All this seems to be right enough, but the column of water resting on the pump piston is partly above and partly below it, and this means to say that the vertical column extends in length from the surface of the standing water in the mine to the surface of the water column at the elevation at which it is discharged. We see, then, that if 20 feet of the vertical column is below the pump piston, the words we commonly use, "*resting* on," ought properly to be *depending* on, for if the mean height of the pump piston above the water in the sump is 20 feet, then 20 feet of column are *hanging* on the pump piston, and 280 feet of column are *resting* on the pump piston. Such a distinction may appear to be out of place, but if you desire to thoroughly understand the mode of action of a pump, the distinction is in place as illustrating the principles involved. Clear views are now within our reach, as, for example, we can investigate how it happens that the 20 feet of the vertical column are *hanging* on the pump piston. As the pump piston ascends it displaces a portion of the pressure of the atmosphere; for, suppose this pressure to be equal to the weight of a vertical column of water 34 feet long and also equal to a pressure of 14.7 pounds per square inch, then the 20 feet of column under the piston has to be lifted by the atmosphere into a partial vacuum made by the piston, and this partial vacuum will be equal to a pressure of $34 - 20 = 14$ feet of column, or $\frac{14 \times 14.7}{34} = 6.053$ pounds per square inch, but the under side of the pump piston makes a depression below the pressure of the atmosphere of $20 \times 62.4 = 1{,}248$ pounds per square foot, or $\frac{1{,}248}{2{,}000} = .624$ tons; therefore, we have

Weight *resting* on the piston	8.706 tons.
Weight hanging on the piston	.624 tons.
Total weight depending on the piston	9.330 tons.

In the values just given, the area of the piston is assumed, as before, to be equal to 1 square foot.

The piston valve *a* is closed by the weight of a column of 280 feet of water resting on it, and by a further addition of the weight of a column of 20 feet of water hanging upon it. The bottom or suction valve is seen to be open, and observe, the piston valve is always closed, and the suction valve is always open during the up stroke of the lift pump; but we should now know the reason why the suction valve is open, and only one answer can be given to the inquiry; and that is, the valve is open because the pressure under it is greater than the pressure above it; then let us now find how this occurs. Take the pressure of the atmosphere at 34 vertical feet of water column, and the height from the surface of the water pumped at 20 feet of water column, and let it require a 1 foot water column to lift the valve; then the pressure under the valve is equal to $34 - 20 = 14$ feet of vertical water column, and the pressure above the valve is equal to $34 - 21 = 13$ feet of water column, then the pressure at *A* is equal to 13 feet of vertical column, or the amount of depression below the pressure of the atmosphere is equal to a vertical column of 21 feet. The student should here realize the true meaning of the terms employed, and to do this consider that the

Total pressure of the atmosphere is	34 feet vertical
Depression below the atmosphere is	21 feet vertical
Total pressure below the pump piston is	13 feet vertical

Next let us proceed to investigate what takes place in the down stroke of the pump piston. By reference to Fig. 156 we see the suction valve is down and resting on its seat as *d*, while the pump piston valve *c* is up, and the pump piston is said to be *plunging* on the down stroke, and, therefore, it is plain, that the pressure due to the weight of the column, has been transferred from the piston valve to the suction valve. Now let us suppose that the suction valve is 20 vertical feet above the surface of the sump water in the pit bottom, and that the total vertical height the water is lifted is 300 feet, as before; then let us find the weight resting on, and hanging on, the suction valve *d*. If it requires a vertical column of 1 foot to lift the piston valve *c*, then let us reckon this 1 foot as weight; then the total vertical column becomes 301 feet, and therefore, the total weight of the column is $301 \times 62.4 = 18{,}782.4$ pounds or $\frac{18{,}782.4}{2{,}000} = 9.3912$ tons on a valve 1 square foot in area, and therefore,

The weight resting on the suction valve is	8.7672 tons
The weight hanging on the suction valve is	.6240 tons
Total weight depending on the suction valve is	9.3912 tons

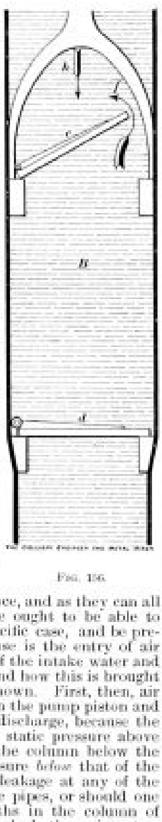


FIG. 156.

The pump piston is plunging into the water space *B*, as shown by the arrow *h*, and the water under the valves is seen by the arrow *f* to be escaping to the upper side of the piston. On the down stroke of a lifting pump, we see that the suction valve is closed and that the piston valve is open.

125. **The Interruptions That Occur in Pump Action.**—Interruptions in the efficient action of pumps are of frequent occurrence, and as they can all be classed under three heads, we ought to be able to determine the cause in each specific case, and be prepared to correct it. The first cause is the entry of air somewhere between the surface of the intake water and the pump piston; and to understand how this is brought about, a few facts require to be known. First, then, air does not enter the column between the pump piston and the upper surface at the head of discharge, because the whole of the upper column has a static pressure above that of the atmosphere; but all the column below the suction valve has a standing pressure *below* that of the atmosphere, and if there is any leakage at any of the joints of the pipes, or should one of the lengths in the column of pipes be cracked, then air enters freely, and in a peculiar way interferes with the pump's efficient action, and such a case as this is shown by Fig. 157. Here, from some cause, air is entering the tail column below the suction valve, and is seen bubbling up at *c*, while it is displacing the water and reducing the depression under the pump piston, as at *d*, and here we see the water head has fallen to *e*. Now this matter requires investigation to find how the air enters the lower, or tail column. This inquiry is capable of an easy answer, for, as has been shown, the *hanging* column is, at every point in its length, at a pressure below that of the atmosphere, and therefore every opening admits air in and presses the water in, for both are subject to a compression on the outside. The causes of the entry of air may be a bad or broken joint or cracked pipe, or the water in the pump may have fallen so low that air is entering the bottom end of the tail pipe with the water.

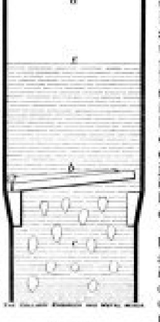


FIG. 157.

The entry of air, however, can be detected by three occurrences, and the first is a great reduction in the volume of the water discharged. The second is the rapid descent and sudden arrest of the piston at half stroke, for the pump rods descend through half of the stroke with the increased energy that is due to the entire weight of the column resting on the piston. The third is the sound of the shock produced by the piston striking the water. Second, the failure of the pump's action may arise from the lodgement of a piece of stick under the piston or the suction valve, and as the behavior of the pump is different in these two cases, let us notice each. When a stick is under the suction valve, the liability to a break up is considerable, because on the down stroke the entire column of water is resting on the pump piston, and therefore the piston's motion is dangerously accelerated, for the water between the piston valve and the suction valve freely escapes. When the stick is under the piston valve, the weight of the column does not rest on the piston, and the pump works as if it had lost all its hold of the water, and the snoring sound of the water rushing through the contracted opening of the piston valve can be heard by placing your ear beside the pump cylinder. Third, a broken pump rod removes all weight off the engine, for the wooden rods, after being disengaged from the piston, practically float, and therefore the engine loses all weight on both the up and down strokes. We now find that all the peculiarities in a pump's action, when it is subject to any disarrangement of its working parts, can be accounted for and corrected by the student who understands a pump's mode of action when all the parts harmonize in the execution of their functions. We have here taken, by way of example, the conduct of a large mine lift pump, but what applies to a large pump equally applies to a small one set up for pumping a local standage of water in the workings.

Recapitulation of Facts.—QUES. 1. What are the positions of the valves of a lift pump on the up stroke?

ANS. The piston valve is down on its seat because the entire weight of the column is depending on it; and the suction valve is up, because the pressure of the atmosphere is at that time forcing the tail pipe column into a partial vacuum.

QUES. 2. Explain the meaning of the terms resting on, hanging on, and depending on.

ANS. Resting on refers to the weight of the vertical column of water on the piston valve; hanging on refers to the tail pipe column that is supported by the pressure of the atmosphere that lifts it into the depression made by the pump piston; depending on refers to the total weight of the column, and is the sum of the weights resting on and hanging on the pump piston.

QUES. 3. How do you explain the fact that the pump piston valve is open and the suction valve is shut on the down stroke of a lift pump?

ANS. On the down stroke of a lift pump the whole weight of the vertical column depends on the suction valve and therefore it is shut, and the only pressure exerted on the piston valve is that due to lifting it by the water that is in course of being displaced by the plunging of the piston.

QUES. 4. Under how many heads may the interruptions of the efficient working of lift pumps be classed?

ANS. The failures in the efficient working of a lift pump may be classed under three heads, as follows:

First, the entry of air somewhere below the piston or suction valve.

Second, the lodgement of a stick under the bucket or suction valve, and especially the latter.

Third, a broken pump rod or the wearing out of the pump piston or suction valve.

(To be Continued.)

CHEMISTRY OF MINING.

The Gauze Cylinder of a Safety Lamp—The Admission of Air to a Safety Lamp—The Ventilation of a Safety Lamp—The Flame of a Safety Lamp Affected by Ventilation—Restrict the Supply of Air to a Lamp—The Recapitulation of Facts.

111. **The Gauze Cylinder of a Safety Lamp.**—It is commonly believed, that the flame of a lamp can be completely isolated with a gauze cylinder, when it consists of wires reticulated with lines of 28 to the inch, to make 784 meshes to the square inch; but this belief cannot be maintained when it is subjected to the object lessons of practical experience, for then we find that the gauze is only one of the factors of security in the construction of a safety lamp. When testing safety lamps to ascertain the extent of their reliability, we learn

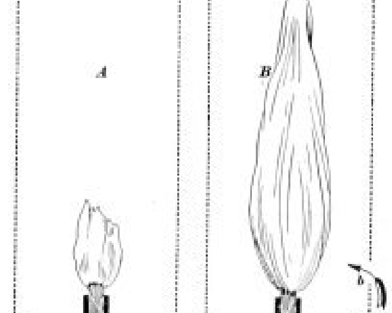


FIG. 150.

much that does not accord with popular ideas; as for example, if you were to propose to make a hole in the gauze cylinder of a lamp by puncturing it with a nail, the prevailing idea is, that the gauze would then be a useless adjunct of the lamp, that might be dispensed with; but testing it in a slightly explosive atmosphere, with a puncture made near the top and just under the cap as at *t* in that portion of Fig. 150 marked *A*, the flame does not elongate as the result of the puncture, but remains of the same size as before. For every effect, there is a cause and that statement is certainly true here, for after the exercise of a little thought we see that the hole *t* does not act as a port for the entry of an extra inflow of the explosive mixture, but as a port of discharge for the products of combustion. It is true that, if we had to select one from two lamps to carry in an explosive mixture, our feelings would make us partial to an unpunctured gauze, but yet the fact remains that a puncture at *t*, is not attended with the same risk as one at *b* in *B*, because an extra inflow at *b* fills the lamp with flame as at *B*; but worse than that, the sides of *b* are *too* far distended to chill a flame, and the result is, a gauze punctured at *b*, *fires at once* when set in an explosive mixture. We see then, that if a gauze cylinder is punctured near the top its efficiency is not impaired, but when punctured near the bottom, its use as a safety appliance at once ceases.

112. **The Admission of Air to a Safety Lamp.**—The facts of the punctures, furnish some instruction that is of great value in the construction of a safety lamp, for we now know that the admission of an excess of air, containing inflamable gas, into the bottom of the lamp, is attended with immediate danger, and that the free and unrestricted discharge of burnt air from the top of the gauze does not in any way imperil the safety furnished by the lamp. The question now before us then, is this: How can we restrict the admission of air into the bottom of the lamp, and yet make such provision as will furnish oxygen enough for the requirements of a good illuminating flame? Before deciding on this point, however, other matters of undoubted importance must be discussed, and the first one is that of a sufficient motive column to maintain a steady and almost invariable supply of air to the flame. In many of the lamps in use, the motive column is entirely disregarded, and the inventors appear to have been concerned about nothing but how best to avert an explosion within the lamp. In this endeavor they were right, and, therefore, the defects that now require a remedy are such as have not received *due* attention. Before the introduction of the bonnet, the ventilation of the safety lamp was like that shown in Fig. 151. The fountain of the lamp and the upper holes are purposely left out of the figure, to make the details of interest, and easier seen and understood.

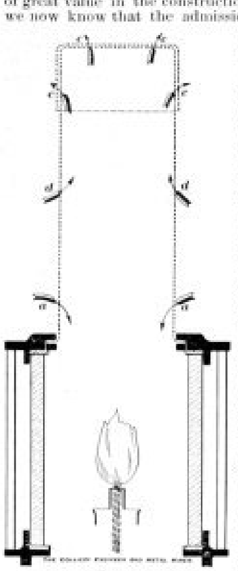


FIG. 151.

113. **The Ventilation of a Safety Lamp.**—The lamp before us is the type of the old Clanny without a bonnet, and the fresh air to feed the flame is seen to enter near the bottom of the gauze, as shown by the arrows *a* and *a*. The cold air will thus descend the glass cylinder as a shell, while the hot gases from the flame will ascend through the cylinder of cold air, but the hot air cannot rise through the cold air without some amount of mixing taking place, and the result is, a portion of the cold air mixes with the hot air and rises with it, and as a consequence of this occurrence, a larger volume of air must enter at *a a* than is necessary to feed the flame; while at the same time, the mixing of the cold air with the hot air reduces the motive column of the lamp's ventilation. Again, above the arrows *a a*, cold air enters and mixes with the ascending hot air, as at and below *d d*, and this entry still further reduces the motive column; therefore, the mechanical action of the ventilation of the lamp is such, that we are astonished when we find how little energy is necessary to blow down sufficient air to the flame to keep it alive. Should, however, the lamp be placed in an explosive mixture, the entry of fire-damp is so much assisted that we cannot but conclude that the lamp under such conditions is really as unsafe as experience has proved it to be. All the air discharged from this lamp escapes through the region of the cap, as *c*, *c*, *c*, *c*. It is pleasant, however, to discover that bad ventilation is a condition of unsafety, and, therefore, to make a safe lamp, the prime condition required to secure this, is good ventilation.

114 **The Flame of a Safety Lamp Affected by Ventilation.**—The flame of a lamp should have an ample supply of air to produce a good light, but the inflow of air should never be in excess, because every fraction of a cubic inch that is more than the flame requires, becomes a danger when the entering air contains inflammable gas. At first sight it appears to be no easy matter to regulate the ingoing supply of air to a lamp when the supply is a *limited* one, but we shall show, further on, how this can be done. A bonneted lamp is no doubt a marked improvement on the old Clanny, but still in many lamps of this type, the objectionable principle is retained of admitting the air at the bottom of the gauze cylinder as we see in Fig. 152; here the ascending hot interior column of air is shown at *d*, while the outer shell of cold air is seen to reach the flame at *c* and *c*, and to enter at *b* and *b*. In this lamp, as in the Clanny, a portion of the motive column is lost between *b b* and *c c*, but a distinct column is maintained between *b b* and *a a*, so that in this respect, the bonnet secures a true gain, but still nothing is done to restrict the supply of air to the net requirement of the flame.

115. **Restrict the Supply of Air to a Lamp.**—An excess of air not only reduces the motive column, but when it contains inflammable gas it supplies fuel for an explosion within the lamp; and to make this clear, let us suppose that the supply is ample, but restricted, and that the entering air is an explosive mixture; here then there is not oxygen sufficient to burn both gas and oil, and the result will be, the flame of the lamp, if it burns ever so feebly, will consume sufficient of the entering oxygen to make the entering fire-damp inexplosive. We here find that something more than a gauze or a bonnet requires close attention in the construction of a safety lamp, and that a lamp devised in harmony with the requirements of natural law must secure an amount of safety far beyond what is obtained when the principles of action are not correctly directed. When the motive column for the entry of air into a lamp is not sufficient, the supply cannot be restricted without, at the same time, affecting the steadiness of the light, for if the entering air contained even a small percentage of carbon dioxide the light would become dim, and the motive column would be reduced, and in some cases the flame would expire. To secure a steady light in a truly safe lamp, we see then, that it is imperatively necessary that two things should be done; first, we must restrict the supply of the entering air; and second, to restrict the supply, the minimum of the restriction must be maintained; and to do that, we must have a good motive column. Here it will be found that we have used a vague term, namely, "*good* motive column," but in future lessons the vagueness will be removed, for then we will be able to determine what is the numerical value of what is here called *good*. To secure a maximum length for the motive column the entering fresh air should not be made to take the form of a cylindrical shell, but should enter the lamp below the heated and burnt gases, for it is only in this way that the minimum supply of air can be provided; and to assist in establishing this conclusion Fig. 153 is introduced. The fresh cold air is here seen to enter the lamp beneath the flame at *c c*, and the products of combustion are seen to leave the lamp at *a*, *a*, *a*, *a*, and as the lamp is bonnetted the hot column extends from the flame to the top of the gauze.

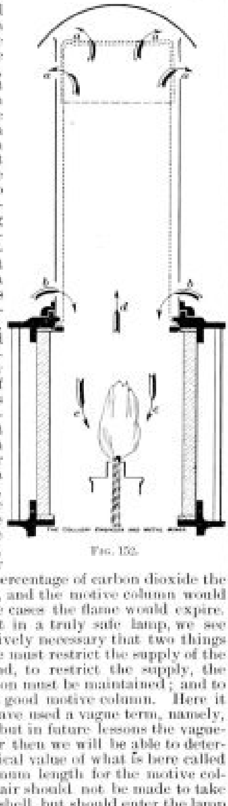


FIG. 152.

We do not doubt for one moment that something more than apertures are required to conduct the fresh air into the lamp and immediately under the flame; but the required provision for this will be one of the subjects of the future lessons, and therefore, for the present, let us decide that the air should by some means be introduced at *c c* with the intention of securing a long motive column and a steady flow.

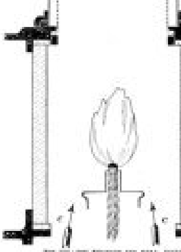


FIG. 153.

116. **The Recapitulation of Facts.**—QUES. 1.—If a puncture is made with a nail just under the cap of a Davy lamp gauze, will this hole reduce the efficiency of the gauze as an isolator of flame?

ANS.—A puncture made just under the cap of the gauze will not reduce the efficiency of the gauze as an isolator of flame, because such a hole is not a port for the entry of an explosive mixture, but for the discharge of the products of combustion.

QUES. 2.—If a Davy lamp gauze is punctured with a nail near the bottom, and just under the flame, will such a hole at all affect the efficiency of this gauze as an isolator of flame?

ANS.—Yes; a hole or nail puncture made near the bottom of a Davy lamp gauze will reduce the efficiency of the gauze as an isolator of flame, because the hole will be a port of entry for the admission of an explosive mixture, and, therefore, an explosion within the gauze will at once ensue.

QUES. 3.—What do you mean when you speak of the motive column of a lamp?

ANS.—I mean that length of a cold column of air that is equal in weight, to the difference in weight, of a cold and hot column, whose lengths are equal to the longest mean length of the hot air column; as for example, suppose the greatest length of the hot air column to be six inches, and the mean temperature of this column to be 600° F., and the temperature of the cold column to be 60° F., then the length of the motive column will be, if we take *d* to be equal to .5, that is, 6 inches or .5 of a foot, $\frac{(T - t) \times .5}{(460 + T)} = M\ C$, that is, $\frac{(600° - 60°) \times .5}{(460° + 600°)} = \frac{540 \times .5}{1{,}060} = .2547$ of a foot, or 3.0564 inches.

QUES. 4.—What occurs when the motive column of a safety lamp is too short?

ANS.—When the motive column of a safety lamp is too short, all resistance must be reduced, and an excessive supply of mine air is therefore admitted, with the result that danger instead of safety is promoted.

QUES. 5.—Where does the air enter and leave the gauze cylinder of a Clanny lamp?

ANS.—The air enters the gauze cylinder of a Clanny lamp from the bottom upward to the underside of the gauze cap, but only the air entering the lower portion of the gauze goes to feed the flame. The burnt air all leaves the gauze by passing through the meshes of the cap.

QUES. 6.—Should the supply of air to a lamp be restricted?

ANS.—The supply of fresh air to a lamp should be restricted, because every cubic inch admitted in excess of that required to maintain perfect combustion in the normal flame, reduces the protective or safety efficiency of the lamp.

QUES. 7.—What advantages does the bonnet secure in promoting the efficiency of a safety lamp?

ANS.—The bonnet acts in the first place as a shield or screen to prevent the air, in rapid currents, blowing through the gauze; and in the second place, it confines the entry of air to the lower portion of the gauze, and thereby increases the safety of the lamp.

QUES. 8.—On what principles should a safety lamp be constructed?

ANS.—A safety lamp should be constructed in harmony with the natural laws that secure the best light, with a minimum entry of air.

(To be Continued.)

MINING METHODS.

Dust in Relation to Current Velocities—Wetting the Dusty Roads—Wetting the Suspended Dust with a Spray—Should the Intake or Return Air be Wetted?—Fine Dust is the Most Inflammable. The Agents that Supply Dust to the Air—Where Best to Apply a Water Spray—Recapitulation of Facts.

105. **Dust in Relation to Current Velocities.**—It was shown in the last lesson that the sizes of the dust particles in suspension in air were peculiar to the different velocities of the currents that supported them, and as such is the case, we ought to be just as able to determine the velocities of a current by the sizes of the largest particles it suspends, as we are able to find the sizes of the dust particles from the velocity of the current. Now the velocity of the current can actually be found in the way suggested and the truth of the statement can be fully established by an experiment with a simple apparatus, such as that illustrated by Fig. 142. First, then make a wire frame 10 inches square and having on the middle of one of its sides a socket to fit on the upper end of a stick, the bottom end of which is stuck into the ground, as shown by the figure. The wire frame carries a sheet of cotton cloth, and this is saturated with water when the arrangement is set up for a test. If at any time the air is highly charged with dust, the cloth quickly becomes blackened, and as we may expect the time of blackening varies with the charge of dust in the current, and, therefore, the time required for discoloration is the index of the state of the air. The speeds of the current are characterized by the presence on the sheet of different sized particles and these can be seen with a good magnifying glass. To distinguish the sizes, peculiar to the different current velocities, however, the observer requires practice in collecting different samples with his wet cloth. In the figure under consideration *w* is the wet cloth and it is seen to be supported by the stick *s*, whose lower end is firmly set in the ground, and in this position a *test* is supposed to be in course of being made. The water used to saturate the cloth ought to contain a deliquescent substance in solution, such as carbonate of potash, for this would prevent the evaporation of the water, or the drying of the cloth, and thereby add to the value of the test. Although this cloth is at the best, only a rough "rule of thumb" sort of a gauge of the dust in suspension in an air current, yet its simplicity of construction, and adaptability for ready application, make it at any rate a good index of whether the air in a room is in a safe condition or not, in so far as coal dust is concerned, for the firing of shots.

106. **Wetting the Dusty Roads.**—The dangers arising from the presence of coal dust in the air, immediately exposed to the flame given off by a shot during its explosion, have been suddenly brought into notice, and, therefore, even the best informed men are affected with the

confusion that always comes with a surprise. There are certain facts, however, that have come across the path of all practical men that bear directly along the line of our present investigation, such as, wetting the roads "to lay the dust," but this statement of what we do, and why we do it, suggests a question like this: In what way does the wetness of the roads lay the dust? and the answer we are likely to give is, When the dust of the road is watered it becomes adhesive and heavy, and therefore, cannot be raised by the scour of the wind sweeping over it. So far, this statement of the mode of action is right, but in what way does the wetness of the floor, roof, and sides of a road affect the dust that is suspended? This last question requires, certainly, a more comprehensive answer than the former one; and more than that, the answer can only be made satisfactory with the help of several riders to the answer to qualify it. The prime answer then is this: All the particles of the air that constitutes the current are, by the deflections from the roof, the floor and the sides of the airway, in their turn, made to sweep over these surfaces, and therefore, by this means the dust particles the air holds in suspension all become wetted and agglutinated, and by this means become too heavy to float, and therefore, sink and leave the air clean. But another question arises out of this, such as how far must the current travel for all the dust it contains to be wetted? and another question is, what weight or volume of water will be necessary to wet the road efficiently? and yet another question is, is it possible to do this extensive wetting in practice for the firing of a single shot? This last rider to the prime question, suggests another very pertinent one, and it is this: Can the dust in suspen-

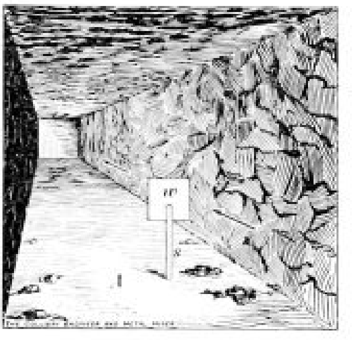


FIG. 112.

sion not be easier wetted and removed by a simpler and cheaper process, than that of watering the roads? and the answer, we are happy to say, is yes!

107. Wetting the Suspended Dust with a Spray.—Before showing, however, which is the best method of purging the air free of inflammable dust, let it be noticed that a large volume of water may be so misused as to effect very little good, while a small volume may be made to so wet the air as to remove all dust; for if the air is wetted with a water spray so fine that the particles of water are nearly as small as the particles of dust, then the air can be more perfectly cleaned with a gallon of water than it could be with one hundred gallons ejected in larger particles; or the one gallon of water ejected in particles so fine that they would float away in the air like smoke would more efficiently purge out the dust than a thousand gallons thrown on the roof, floor and sides of a road; for an air current saturated with dust must travel a long journey before the wet sides of the road can effect any good. Water ejected at a high pressure out of very fine perforations may be made as fine as the water dust of condensed steam, and where hose cannot be applied, a portable vessel may be made to run on a truck, and the necessary pressure may be obtained with compressed air pumped into the water tank, and if even this appliance can not be used, then small vessels can be carried by hand to eject a fine spray at a high pressure; this can be done by the injection of compressed air into the vessel with a forcing pump.

108. Should the Intake or Return Air be Wetted?—Another very important matter requires our attention in relation to dust in suspension, and it is this: Should the air be wetted before entering the locality of the shot, or should the air, and roof, and floor, and sides be wetted on the return side of the shot? Suppose the watering to be done on the side along which the air is leaving the locality of the shot, then it may be said that any flame produced by the shot will be cut short on entering the clean air that contains no fuel for further combustion, but during the time that elapses in the retreat of the fire boss from the shot to a place of safety, the ingoing air charged with dust has had time to displace the clean air and make the danger as great as ever. We see, then, that little good can be effected by wetting the return air, and therefore the flame from a shot ought to be so isolated with clean air, that, at the period when the shot is fired, not only the locality of the shot, but the air entering it, should be entirely free from dust. To secure this desirable result it is necessary that the ingoing air should be wetted and purged, for then, instead of the period of the retreat from the shot being one during which the danger increases, it would be one during which the danger decreases, and if this conclusion is a correct one, we see at once the importance of the matter.

109. Fine Dust is the Most Inflammable.—The finest dust will be much more inflammable than the grosser varieties, and this may be classed as danger number one. Again, air parts with its grosser dust the moment the velocity of the current is reduced, while the finest dust remains in suspension at very low velocities, and this fact may be classed as danger number two. But fine dust is easy wetted and purged out of air with a fine spray, and this constitutes safety number one, while a less volume of water is required for wetting air with a very fine spray than with a large volume of water improperly applied, and this furnishes safety number two. We now see the importance of knowing the true character of suspendable dust, for, while others think that the most dangerous dust is suspended in air currents of high velocities we now know that the most dangerous varieties of inflammable dust are contained in suspension in air currents of low velocity, and we now further know that to purge the air of its dust we must use a water dust in which the particles are nearly as small as those of the dust they are intended to remove.

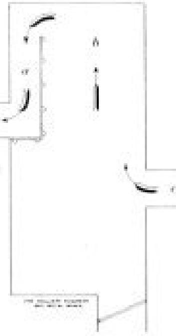


FIG. 143.

110. The Agents that Supply Dust to the Air.—We have given full attention to the study of the suspension of dust particles and now we are about to consider where and how the supply of dust is furnished, and we shall find the latter enquiry is only second in importance to the former one. The supply of dust is furnished by three agencies, and these are, the cutting of the coal, the filling of the coal, and the haulage. But for the dust given off by the shake of the cars during their haulage to the shaft, the ingoing current of the principal intake airway would be free from dust, and this state of purity would continue until the fresh air reached the first chamber or room to be ventilated. We can then see that the dust taken up in suspension by the air in the first chamber is borne forward into the second one, and then on from the second to the third, until the same distinct current has gathered dust accumulatively from the first to the last room in the series, when it enters the main return airway in a highly charged condition. The last fact that has engaged our attention suggests an important conclusion, namely, that the dangers arising from the ignition of coal dust are greater in the last room of a series ventilated than in the one that first receives the clean fresh air, unless the air is first purged with a water spray. We can see by an inspection of Fig. 143 that, if the air entering at *c* brings with it a charge of fine dust suspendable in a current of low velocity that comes from a former room, by the time this current arrives behind the brattice at *a* it will have taken up a second charge from *b*, unless the entering air is purged before emerging from *c*.

111. Where Best to Apply a Water Spray.—Again we are confronted with another question, which is this: Where should we apply the spray to effect the best result in purging the air? In answering this question, thought and caution must be exercised, because prudence is the best director in such important matters. If we apply the spray on the wide side of the brattice, we must either use more water or make the spray finer and use more time, and even then the air will never be efficiently purged, because the incoming air will enter at a higher velocity than that of the wide current in course of being operated on, and the result will be a continual mixing of the charged and purged air. We see, then, that the air should be wetted and purged before emerging from *c* to obtain the most efficient and economical results. Now, on the face of all this, the reader will see that if coal dust is attended with the dangers that are claimed for it, and perhaps none of us doubt the accuracy of the evidence, there is a right way of proceeding to purge the air and reduce the danger to a minimum.

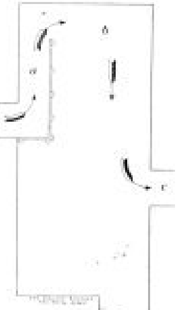


FIG. 144.

There are two things that require attention with regard to coal dust in air and the firing of shots. The first is, we require some ready and simple means of testing to find if the dust is present in dangerous proportions, for if it is not, then we may dispense with the use of the spray; and on the other hand, if the proportions of dust are found to be really dangerous, then we know that it would not be safe to fire a shot until the air is purged. The great thing to be done, however is to devise a testing apparatus that is simple in construction and in use, and until what we propose is done, the wet cotton cloth may be taken as better than no test, for it will at any rate indicate when the air is heavily charged. When the ventilation of a room or chamber is so carried on that the entering air comes up behind the brattice, as in Fig. 144, the conditions for purging the air with a spray are highly favorable, for if the shot has to be fired in the neighborhood of *b* the clean air from *a* will displace all the dust-charged air along the working face, and prevent even the possibility of the prolongation of the flame of a shot. Another matter associated with this figure requires attention, and it is this, if the air ought to be sprayed before entering a room when a shot has to be fired, the same rule should be applied throughout the mine, wherever the entering air is likely to be saturated with fine inflammable dust.

Recapitulation of Facts.—QUES. 1. Does watering the roads, or projecting a spray into the air current of a mine do the most good?

ANS. A fine water spray at once drenches the dust particles and causes them to agglutinate and gravitate out of the air, whereas when the roof, floor and sides of a road are watered the current has to travel over a great length before the dust is arrested.

QUES. 2. Should the ingoing or return air be wetted with the water spray?

ANS. The ingoing air, or the air entering a locality where a shot has to be fired, should be purged with a water spray, for then if the work is well done no explosion can occur by the ignition of the inflammable coal dust in the air.

(To be Continued.)

A Large Electric Mining Plant.

A few months ago we described the interesting power transmission plant installed by the General Electric Company at the Silver Lake Mines of Mr. E. G. Stoiber, at Silverton, Colo. The introduction of electricity into the operation of the mines has resulted in economy so noticeable that an increase in the plant is now being made to provide for an extension of the system in the mines and to reinforce the water power which is not sufficient to furnish all the power required throughout the year.

Two cross compound Corliss engines, with cylinders 24" x 46" x 48", each engine of 850 I. H. P., are now being set up, together with water tube boilers, mechanical stokers, coal and ash conveyors, feed water heaters, separators, water meter, coal weighers, the whole making what will be the most thoroughly modern steam plant in the state.

The difference between the cost of coal at the power house and its cost at the mine, which is at greater elevation by some 2500 feet, is such that the saving effected, even when steam power is used for generating purposes, will insure an ample return on the investment, while the economy induced by the use of the water power is considerably greater. Mr. Stoiber, therefore, feels that in adopting electricity for the operation of his mines he has more than considerably diminished the cost of working them.

The present plant now in operation consists of two 150 K. W. General Electric three phase water driven generators, supplying current to one 100 H. P. motor for the mill; one 100 H. P. motor for the air compressor; one 75 H. P. motor for the hoist; one 15 H. P. motor for the pump; one 1 H. P. motor for a blower and incandescent lights scattered throughout the station, mill and mine. The additional plant will consist of two 150 K. W. General Electric generators, one 100 H. P. motor for the mill; one 15 H. P. motor to drive a pump, and two 10 H. P. motors for blowers, forges and miscellaneous machinery, and to eventually utilize to the full the capacity of the steam and water power plants, additional and larger generators will be set up.

Not the least interesting feature of this installation, is that although the entire output of electrical energy is to be used in the operation of a single mining property, it will be, when completed, the largest electric power plant in the State of Colorado.

Cahall Boilers.

The Carnegie Steel Company, nearly two years ago, being favorably impressed with the design of the Cahall vertical water tube boiler, made an investigation as to its merits, the result of which induced them to put in a trial plant of these boilers of 2000 horse-power at their gas pumping plant at Bagdad, Pa. The performance of the boilers at Bagdad was such a marked improvement over the general boiler practice of to-day that they about a year later put four of these boilers at their Edgar Thomson Steel Works. They very carefully watched and tested the boilers at Edgar-Thomson under varying conditions, with the result that they have been so well satisfied with the work done by those four that they have made arrangements to tear out all the old style boilers at furnaces A, B and C at the Edgar-Thomson Steel Works, and have purchased 5250 horse-power of the Cahall vertical water tube boilers to be installed at these furnaces in place of the ones they will remove.

Water for Steam Purposes.

The dry season, with the accompanying scarcity of water for steam purposes at many coal mines, is again upon us, and any suggestions as to a remedy for the trouble we feel sure will be appreciated by our readers.

No company has had more trouble from this source than the Philadelphia and Reading Coal and Iron Co., and the officials of that company have spared neither time nor expense in endeavoring to utilize water more or less impregnated with mine water for steam purposes. The greatest success achieved was during the dry season of 1895, when they first tried and then adopted the Pittsburg Boiler Scale Resolvent, an economical and efficient preparation that prevents both scale and corrosion.

This preparation is made by the Pittsburg Boiler Scale Resolvent Co., Pittsburg, Pa., and it is guaranteed by the makers. It is now used by many of the leading mining companies of America.

English Wire Rope.

Messrs. George Cradock & Co., of Wakefield, England, extensive manufacturers of wire rope, whose advertisement has appeared in our columns for over a year past, request us to announce that Mr. T. A. Wigham is no longer connected with them in any way, and that, for the present, American customers are requested to communicate directly with them at Wakefield, England. Messrs. Cradock & Co. are desirous of securing live responsible agents in every American mining field.

MISCELLANEOUS.

SCENERY OF THE MOON.

Notwithstanding that the moon is 240,000 miles distant from the earth, it would in some respects be hardly an exaggeration to assert that we are better acquainted with the topography of our satellite that we are with that of the globe which forms our home. It is a peculiarity of our satellite that it manages its movements in such a manner as to withhold nearly half of its surface from ever being inspected. It follows that we have no means of learning what is on the other side of the moon. So far, however, as the neighboring globe is displayed for our observation, we can certainly assert that there is hardly a spot possessing the size of an ordinary parish which has not been studied and photographed, sketched by competent draughtsmen, duly laid down on elaborate charts of the lunar surface, and in many cases received the dignity of a special name.

For the purpose of the terrestial astronomer, it fortunately happens that the moon is almost entirely destitute of atmosphere. The features of its surface are consequently never obscured by any of those causes which would tend to hide the features of the earth from outside scrutiny. Whenever the clouds on our globe are out of the way, it is then possible to observe the moon with but little obstruction. If we also remember that many of the features of our satellite are within reach of a telescope of comparatively moderate power, it will not be surprising that the lunar scenery has attracted so much attention and that thousands of minute features on its surface have been carefully identified.

When we look up at the full moon, even without calling the telescope to our aid, we at once notice the presence of a number of large dark patches. The appearance of these dark spots, in days before telescopes were employed, suggested that those objects were basins of water, and accordingly they were anciently called "seas." In modern days, astronomers have somewhat awkwardly retained this name, or its Latin equivalent, to designate these peculiar dark tracts, notwithstanding the fact that there are sound physical reasons why it does not seem the least likely that there could be any water in the fluid form present in our satellite.

No doubt it seems the simplest supposition, so far as certain phenomena are concerned, to believe that they are the basins in which great seas did once roll, but that as the moon has gradually cooled down from a primeval state in which it was largely composed of molten matter, the water from the seas penetrated into the interior, and there entered into chemical union with the materials which were crystallizing. There are, however, many who believe that these dark regions are due to the pouring forth from the interior of vast volumes of molten lava which spreads over deep hollows, burying more or less completely the objects which had previously occupied them.

The most characteristic features of the scenery of our satellite are, however, the remarkable objects which are the results of volcanic phenomena. There are many classes into which these objects can be divided, but it will be sufficient if we attempt to give some brief account of what may be called the walled plains, and of the volcanic craters properly so termed. The most perfect example of a walled plain on the moon is the great object known as Ptolemæus. The remarkable district so designated covers an area on our satellite considerably larger than Wales. It is situated nearly centrally on that face of the moon directed toward us, so that it generally lies very conveniently placed for examination, and is the last of a chain of four magnificent objects of the same character, which lie along the coast of that darkest of lunar seas, known as the Mare Nubium. Ptolemæus may be described as almost circular in outline, though sometimes it might be regarded as a rudely six sided figure. Its appearance may be compared to that of an eyeglass, whereof the little handle is formed by a beautifully shaped crater bearing the name of Herschel. The floor of Ptolemæus is a plain, not much depressed below the general level of the lunar surface.

To my mind, however, the most interesting of these objects, as well as perhaps the most perfect representative of its class, is the beautiful walled plain named Plato. No other object of the same character happens to lie in its neighborhood, and, consequently there is but little difficulty in distinguishing it.

There is also another circumstance which is sometimes apt to puzzle the beginner, for, owing to what is called the moon's libration, the face which is directed toward us is not always exactly the same. The difficulties will, however, not prevent the student from readily identifying the superb object known as Plato. It lies in the northern region of the moon, and as our telescopes exhibit the object inverted, this means that Plato must be sought at the lower part of the field.

This walled plain is situated on the coast line of a magnificent lunar sea, namely, the Mare Imbrium, which may, perhaps, be described as a stupendous gulf branching off from the Oceanus Procellarum. The floor of Plato measures about sixty miles across. It may be said to be flat, with the exception of certain small irregularities; but the fact which chiefly strikes the attention of the observer, and which is specially noticeable in the photographs, is the unusual darkness of that floor as compared with other parts of the moon. The rampart of mountains which surrounds Plato is comparatively perfect, and no more pleasing lunar picture can be beheld than when the shadows of these mountain peaks lie stretched along the dark central floor, as they do when the sun is in such a position that it would just appear to be rising to the lunar inhabitant who was stationed in the neighborhood.

The shadows of lunar mountain peaks not only greatly enhance the beauty of our lunar picture from a spectacular point of view, but they have another importance. They present to the astronomer the only means which he possesses for measuring the altitudes of the lunar mountains. For, as a lunar mountain is more or less pointed toward the observer, its elevation above the surface cannot be attained by direct measurements.

The isthmus on which Plato is situated contains many other interesting objects. Beginning at the northern point, we first come to the very remarkable bay known as the Sinus Iridum. Then comes Plato, and then the gulf sweeps round by a noble range of mountains called the Caucasus, between which and the range of the Appenines there is a passage which leads into the Mare Serenitatis.

At this point the observer will notice three splendid rings lying out in the Mare Imbrium. The smallest of these is the Autolycus. Directly below that is the larger ring known as Aristillus, which is 34 miles in diameter. Its rampart rises upward of two miles above the surrounding plain, while the interior of it is depressed some 3,000 feet below the level of the general lunar surface. Aristillus may be regarded as a typical lunar crater, inasmuch as it is adorned by a lofty mountain peak ascending from the center. The third of the three craters which form this noteworthy group lies far out in the Mare Imbrium, and is the famous lunar object known as Archimedes. This crater is not quite so large as Plato, but its floor presents multitudes of points of interest to assiduous lunar observers.

Returning, however, to the neighboring coasts from our survey of these objects out in the Mare Imbrium, we perceive the splendid range of the lunar Appenines. The objects so called are by far the most magnificent range of mountains that can be seen on the moon, ascending, as some of its peaks do, to an altitude of about 18,000 feet above the surrounding plain. This superb range extends for a distance of no less than 400 miles along the shore of the Mare Imbrium, and the special summits which have been noticed upon it are to be numbered in hundreds. The Appenines project a mighty promontory into the Mare Imbrium, which terminates in the crater known as Eratosthenes. This object is of interest as being, perhaps, the volcanic vent for the mighty forces which were once concerned in the upheaval of this mountain range connected with it.

The promontory thus magnificently ended points to another lunar feature. This is the great crater Copernicus, which is regarded as the most noteworthy object of the moon. It stands isolated in the Oceanus Procellarum, and this peculiar situation gives to Copernicus a distinctness which makes it very easy to recognize. Among the features which makes Copernicus specially interesting as a telescopic object are the remarkable terraces which are to be seen in its interior. They are apparently due to successive floodings of the crater by lava. It seems probable that they were produced during some outbreak when the crater became filled with lava, then after a period of quiescence the surface of this would become congealed. If the molten lava beneath subsided it would leave a margin of solidified material, which would form the first or highest terrace. At a subsequent outbreak the basin might have been only partly filled, so that the lava did not ascend to so great an altitude. This would in due course become congealed on the surface, and again the lava would subside, thus forming a second terrace.

A remarkable characteristic of lunar scenery which is displayed on a grand scale by Copernicus, is the presence of bright radiating streaks which extend from the great crater for many hundreds of miles over the lunar surface. The explanation of these bright streaks offers one of the most difficult problems in lunar physics. They are sometimes thought to mark lava flow from the central spot at some earlier phase of eruption than the crater as it now stands would indicate. It does not, however seem apparent why these streaks should in this case possess the peculiar brightness which characterizes them.

Near the southern pole of the moon is the remarkable crater known as Tycho. This is situated in a region where the scenery indicates the wildest and most magnificent confusion. Tycho is specially noticeable for the number of bright streaks which radiate from it. Indeed, at the time of full moon, when these streaks are peculiarly visible, they have frequently been likened to meridians diverging from a pole.

One more striking feature in the scenery of our satellite should be referred to. I mean the deep but narrow clefts or chasms which extend for hundreds and often for thousands of miles across the lunar surface. These chasms seem in all probability to owe their origin to earthquake shocks, by which the moon was shaken in the days when its volcanoes were still active. Those days seem, however, to have long since passed. The volcanoes on the moon no longer give any manifestation of energy.—*Condensed from an article by Sir Robert Ball in The New York Sun.*

THE TOMBS OF ANCIENT KINGS.

Theorists have discovered, or think they have discovered, many wonderful properties about the Pyramids, but we should not lose sight of the main fact that they are merely vast heaps of stone, exquisitely built indeed, that mark the graves of monarchs who wished to keep their mummied bodies inviolate for all time.

The Egyptians built their houses for the living of perishable brick; they built their houses for the dead of immortal granite. There was a reason for this, founded upon the theory of human life and death. They regarded man as composed of several entities, each having its separate life and functions. First was the body; then the *ka*, or double, which was an etherial duplicate, feature for feature, of the corporeal form; then was the soul, which was popularly represented as a human-headed bird, and after the soul came the "luminous," a spark from the divine fire.

By process of embalmment they could suspend for ages the decomposition of the body, and by means of prayer and offerings the other component parts were saved from the second death, thus causing prolongation of existence. The "double" never left the body, but the soul and the "luminous" went forth to follow the gods, returning now and then to the resting place of the body. Thus, the tomb was called the "eternal house" of the dead, compared with which the houses of the living were but wayside inns, and, therefore, if possible, these eternal houses were built as durable as all time. The tomb must contain a private room for the soul, which was closed at the time of burial, not to be opened under any circumstances. It must also contain a wide passage or reception room, where priests and friends made offerings for the dead. Indeed, the tomb was looked upon as a permanent dwelling, and it was built to promote the well-being and insure the preservation of the dead.

The construction of the Pyramids and other imposing tombs illustrate this idea, and the success with which these ancient Egyptians preserved the mortal remains of their royal dead is seen in the mummies that retain their facial expressions after thousands of years.

The great Pyramid of Cheops, at Gizeh, the most prodigious of all human constructions, covers thirteen acres at the base and weighs about seven million tons. Originally it was 480 feet high, and it is estimated that the materials that were used for its construction would build over 20,000 eight-roomed cottages and house a population of 150,000.

Like most of its fellows, it stands exactly square to the four points of the compass. The great limestone blocks, some of them five feet broad and high and thirty feet long, were brought from distant quarries, propelled, doubtless on rollers from the river along a well-laid causeway to their present site. Mechanical appliances, as well as the art of cutting and polishing the hardest stone, were familiar to these Egyptians of 5,000 years ago.

Twenty years, Herodotus tells us, the great Pyramid was building, and, when it was completed, instead of presenting the rough series of steps it does now, the whole edifice was cased with shining red syenite, brought from the first cataract, 500 miles away, which caused it to glisten so brightly that it was known as the "Pyramid of Lights." Until the Arab conquest it preserved this stone casing, so wonderfully joined as to appear like one block from base to summit.

In the inside everything was arranged so as to hide the exact place of the sarcophagus and thus baffle all would-be spoilers of the royal tomb. The entrance was found to be nearly in the middle of the north face, at the level of the eighteenth course, about forty-five feet from the ground. When at last the casing was torn off and the block of stone was displaced which covered the entrance, an inclined passage 41.2 inches wide and 47.6 inches high was revealed, the lower part of which was cut in the stone. This descended for 317 feet, passed through an unfinished chamber, and ended sixty feet further in a blind passage. In from the door a block of granite was found which shut from view another passage. This obstacle being passed, there came an ascending passage which divided into two branches—one running into a limestone chamber in the center of the Pyramid; the other, continuing upward, became a gallery 148 feet long and 28 feet high, built of Mokattam stone, so polished and finely wrought that we are told it was difficult to put a needle or even a hair into the joints.

Another difficulty must now be surmounted. The final passage leading to the chamber of the sarcophagus was closed by a slab of granite, and further on was a small vestibule divided in equal spaces by four partitions of granite, which must be broken. When at last it was reached the royal sepulchre was found to be a granite chamber 19 feet high, 34 feet long, and 17 feet wide.

The second Pyramid of Gizeh, built by the brother of the builder of the first (according to Herodotus) retains some of its original casing at the top; and round the third, the Red Pyramid of Menkara, where it is supposed once lay the body of the beautiful Queen Nitocris, a Loreley legend has grown up. The queen's blushing face caused her to be confounded with the rosy-cheeked Rhodopis, the Greek favorite of King Amasis, and superstition imagines that a fair but treacherous woman haunts the Red Pyramid and bewitches travelers. —*From the Baltimore Sun.*

ONE OF NATURE'S PROVISIONS.

Man's inventions follow nature's lead, only they lag far behind. The cold storage of fruit is a modern device for the supplying of man with fruit long after the fruit-ripening season is over; but nature had done the same thing from time immemorial. Mr. Henry Seebohm, a famous English ornithologist, surprised from nature her secret, and discovered her great cold-storage system.

In the course of his researches he was led to visit Petchora River, which flows from the Ural Mountains into the Artic Ocean near Nova Zembla. Along the lower part of the river he found what seemed the most uninviting district—an uninhabited, treeless swamp, stretching on either side of the stream, and known as the tundra. Higher up the river was the great Siberian forest, but here in the tundra was nothing but hard, frozen snow. Yet this unattractive spot was found to be the summer home of half the bird population of the Old World.

Mr. Seebohm reached it in the beginning of April. Forest and tundra were as bare of life as the Desert of Sahara; but a change was coming. Suddenly summer broke over the scene, and with it came the birds. The ice in the river split and disappeared, the banks steamed in the sun, and innumerable birds of all sizes and colors appeared within forty-eight hours after the first warmth.

The once frozen tundra now showed itself to be a moor, with here and there a large bog and numerous lakes. It was covered with moss, lichens, heath-like plants, dwarf birch and millions of acres of cloudberries, cranberries, and crowberries. This was the storehouse of the feathered tribes.

The perpetual sun of the Arctic summer causes the plants to bear in wonderful profusion, so that fruit was abundant. But fruit-bearing does not come before blossoming, and blossom and fruit cannot be perfected in forty-eight hours. The little travellers were arriving by thousands. The fruit would not be ripe before the middle or end of the Arctic summer, and if the birds had to wait till then they must needs starve.

Not so, however, does nature provide for her pensioners. Long before the snow had melted, provision had been made for their maintenance. Beneath the snow lay the whole crop of last year's fruit, perfectly preserved by nature's system of cold storage.

Each year when the berries are ripe, and before the birds can gather them, the snow descends upon the tundra, effectually covering the crop, and preserving it in perfect condition until the spring sun melts the snow and discloses the bushes loaded with ripened fruit, or, in some cases, the ground beneath the plants, covered with the fallen treasure waiting for the hungry strangers. The berries never decay beneath the snow, but keep in perfect condition, and are accessible as soon as the snow melts. Nature's cold storage is never a failure.

Nor need the visitors depend on fruit alone for sustenance. The insect-eating birds are also provided for, and all may take their choice of fruit or flesh. The same heat which frees the fruit also brings into being the most prolific insect life in the world. No European can live there without a veil after the snow melts.—*From The Spectator.*

WHY SAND FLOATS ON WATER.

It is quite well known that small, dry particles of substances of greater specific gravity than water will float upon it, by reason of capillary action. The surface tension of the water enabling the water to form a depression somewhat larger than the particle, this has the same result as if the specific gravity of the particle had been decreased. The phenomenon observed by Mr. Simonds at Llano river is interesting, as the granite sand was larger and heavier than the dust which had usually been observed heretofore. He tried various kinds of sand and found that they all floated with one exception. Mr. Simonds says:

"The morning after my arrival, the river was found to be rising, and, as I stood on the bank, at the point where we secured our water supply, I noticed a considerable froth and what appeared to me at the time scum passing down the stream. I spoke of the condition of the river to my companion, Mr. Laurence D. Brooks, of Austin, who remarked that what seemed to be scum was really sand. I thereupon went down to the water's edge, and, dipping up some of the floating material, was astonished to find that the patches were composed of sand, mainly of quartz. At this time—half-past nine or ten—the water supported a large number of patches, which varied in area from less than a square inch up to several square inches, all swept along by the current. * * *

"A week later, when the river was well down and the sandy stretches of its bed had become quite dry on their surface, I gathered sand by handfuls, and sent it floating down the stream in such quantities that the sand rafts actually cast shadows on the bottom as they passed.

"When shaded, it will be seen that the floating sand grains cause a depression of the water's surface, which indeed is quite as apparent in the case of isolated grains as in that of patches. I recall one instance where the depression, of very short duration, possibly but a few seconds, was so great as to be positively startling. As I was sprinkling some sand upon the river, for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed like a funnel for say half an inch, before the cause of this unexpected phenomenon broke through the surface and sank to the bottom.

"It appears from these and other observations that the weight of the sand grains actually depresses the surface of the water; yet the elastic reaction of that surface is sufficiently great to prevent them from sinking, especially when the resistance offered by their angularity is taken into consideration. In the launching of grains the more rounded would tend to roll over in the water and thus become wet, in consequence of which they would sink, while those of an irregular shape would overcome the tendency to roll and remain partially dry, thus fulfilling a condition necessary for floating."—*From the American Geologist.*

A WORD WITH THE DOCTOR.

An invaluable aid for the preservation of one's health and spirits is to go out of the house, on some fixed errand, every day of one's life. This is not so easy as it seems, and all men and women know that it is not. But the practice, if carried on ever so short a time, will plead for itself. We get into very bad habits of staying within doors, and foregoing the change of air and scene and interest that is absolutely necessary not only to a broader mind, but also to a sane view of things in general.

⁂

The following are homely remedies for neuralgia: Boil a handful of lobelia in half a pint of water, strain and add a teaspoonful of fine salt. Wring cloths out of the liquid, very hot, and apply till the pain ceases, changing as fast as cold, then cover with dry cloths for a while, to prevent taking cold. Two large tablespoonfuls of eau de Cologne and two teaspoonfuls of fine salt mixed in a bottle make an excellent mixture to be inhaled for facial neuralgia. Horse radish, prepared the same as for the table, applied to the temple or wrist, is also recommended.

⁂

A good household remedy for burns can be made by mixing equal parts of raw linseed oil and lime water.

⁂

Wormwood boiled in vinegar and applied as hot as can be borne on a sprain or bruise, is an invaluable remedy. The affected member should afterward be rolled in flannels to retain the heat.

⁂

If castor oil is applied to a wart once a day for a month the wart will entirely disappear. In many cases it will not require so long a time.

⁂

Did you ever notice the way a physician prepares the court plaster for a wound? First, fold the piece lengthwise directly through the middle. The plaster should be considerably larger than the wound to keep well over the edges. Then slash the plaster lengthwise nearly to the edge. Straighten the court plaster out flat, and cut the slashed pieces at opposite ends. Place the straight edges of the court plaster to the flesh on either side of the wound, bringing the strips across the wound. Moisten them, and, taking a strip from each side, draw them together gently, closing the cut, and stick the plaster in place. Continue with all the strips, and the cut will be dressed in a manner to insure a perfect healing, and as well as any doctor could do it.

⁂

Defective hearing is a trouble that many children labor under, caused occasionally by disease, but oftentimes by lack of proper care of the ear passages. It is sometimes the case that the dullness and inattention of a scholar are due to impaired hearing, and the inability to hear distinctly gives the poor child the appearance of being heedless and inattentive.

The waxy secretion found in the ears is nature's own method of keeping the ears in a healthy condition. There is frequently, however, an excess of this wax, and occasionally it happens that, in cleaning the child's ears, the excess of wax is pushed further into the ear passages. Repetitions of this process cause the wax to become packed, causing gradual loss of the hearing power. Too much stress cannot be laid upon the fact that pins and such articles should not be used in the care of the ears, as serious injury is liable from the article entering too far.

Glycerine and warm water in equal parts is a mixture that will dissolve and remove the wax. Apply gently with a small syringe. Should there be at any time anything in the nature of discharges from either ear, a physician's advice should be sought without delay. In such cases there is almost certain to be some disease of the inner ear passage requiring medical attention. Prompt attention will probably save the child serious impairment of hearing, if not utter loss. It should be noted that teething may have close relationship to trouble in the ears, due to the swelling and inflammation of the gums. This inflammation is liable to extend through the eustachian canals to the ears; and any tenderness accompanied by redness around the ears, is a sufficient indication to warrant calling the physician's attention to the matter.—*From "The American."*

"HOW DO YOU DO?"

An American lady who spent some time in Paris says that she had a friend there, a French lady, who wished to learn a little English, and did so. Among her acquisitions in the language was the expression, "How do you do?" to which she was careful to learn the proper response.

One day the American lady met her French friend on the street. The American lady said, "How do you do?" with a smile, and passed on. She did not stop to notice that she had left the French lady standing on the street in astonishment.

Soon afterward she called on her friend, and was received very coldly by the French lady. As she did not know of any reason why the lady should be offended with her, she pressed her to tell her what was the matter. "Have I done anything to grieve you?" she asked.

"Anything to grieve me!" answered the French lady; "You meet me on the street, you ask me how I am, you do not wait to find out how I am, you pass on, and then you ask me whether you have done anything to grieve me?"

Then the American explained that it was not customary for Americans to wait for an answer to their inquiry, "How do you do?" that they commonly only utter the words and pass on, or if they stop to speak, at once begin to talk of other matters.

That this was the case she was able to prove by taking the French lady to a hotel where there were several Americans, and allowing her to hear their salutations, "How do you do?" "How do you do?" unaccompanied by any account of *how* they "did."

The French lady could hardly express her astonishment. "The Americans do many very, very strange things," she said, "but this is the strangest of all!"

The French when they are of the degree of acquaintance which justifies inquiry as to the health of another, stop and hear all about it, and all about the health of the respective families. When all this information has been exchanged the two persons part with many adieux and elaborate good wishes for each other's continued health and happiness.

The Italians frequently embrace one another in public places, and shake hands several times, and commit one another in parting to the care of God. The Americans and the English are the only people who question each other as to their health without stopping to find out anything about it.—*From The Youth's Companion.*

COLOR-BLINDNESS.

Persons may be born with color-blindness, or they may acquire it in after life. In the former case color-blindness is not, strictly speaking, a disease, but an imperfection of vision dependent upon some unknown cause. Its appearance in later life is significant of many diseases of the eye.

Color-blindness, especially that form of it which exists from birth, may be of any degree up to an inability to recognize any color whatever, so that the whole external world looks gray, like an engraving. Cases of this extreme kind are rare; but cases in which the blindness is limited to one or two or a group of colors are frequent enough.

The scientific explanation of color-blindness is easily understood and very interesting. It is based upon the theory that there are in the eye three sets of nerves, which correspond to the fundamental or primary colors. Perception of any one of these primary colors arises from the stimulation of the corresponding nerve by the light which is reflected from the color. Sensation to the remaining colors originates through a varying mixture of stimulation of two or all of the nerves.

Partial color-blindness, then, is simply the inability of any one of the nerves to correspond to proper stimulation; an inability which not only renders the afflicted person unable to distinguish a particular color,—red, green, or violet, as the case may be,—but makes him "blind" to all compound colors into which the primary color enters.

We are not to suppose, however, that the affected nerves are entirely insensible, for that would imply that the colored object would either be unapparent or seen as entirely colorless. Each of the groups of nerves of which we have spoken is set in action by all kinds of colored light, but to different degrees of intensity. Some nerves are affected most strongly by rays from red objects, less so by yellow, still less by green, and least of all by violet colors. These nerves are designated as the nerves for the perception of red. Other nerves respond more strongly to yellow, others to green, and so on.

Color-blindness may exist for years undiscovered, to be discovered at last by the committal of some gross mistake, like that of the tailor who wanted to mend a black coat with a patch of red.

The fault is one which can never be cured, although many persons, relying upon the brilliancy which certain colors present over others, appear to be able to correct their error of sight.—*From the Youth's Companion.*

THE FRONTIERSMAN'S RIFLE.

An old-time plainsman, writing about the good points of the old-style rifle, says: The modern riflemen do not appreciate the possibilities of the old-fashioned arms of the kind Daniel Boone thought perfect. There was no such phrase for the frontiersman as "accurate enough for hunting," which is common these days. A rifle which a frontiersman owned had to be one he could bet his life on and win. It must be, above all, accurate. If it was aimed at a candle wick, it must must not hit the candle. If aimed at a man's heart, it had to hit it, and not an arm or ear. Up to 200 yards the accuracy of the old weapon, the pea rifle, has not been excelled, and few modern rifles equal it.

In these days of pump guns, which throw bar lead out of the muzzle and brass pipe out of the breech, accuracy is thrown to the winds. If the first shot misses, why, a second later another is ready. Not so with the muzzle loader. The game was in sight for just one shot, and no more. If that shot was not fatal, more game must be searched for. Knowing this, the old-time hunters drew down and shot for meat. They did not pull when the sights were in line with a leg or the paunch. When they pulled the set trigger, the sights were in line with the heart, head, throat or back, and the whip-crack of the weapon oftener meant death to the game than the rip-roar slam of a modern repeating rifle.

A man who would use a shotgun for game in those days was a contemptible freak, and even to-day the shotgun users respect the man who uses a rifle for shooting birds' heads off, instead of using a scatter gun. The frontiersman trusted his rifle. It was "Bess," or "Chain Lightning," or "Kills 'em Quick," to him, not just "my rifle." He said, "Me an' Bess got a deer yisterday," and when "Bess" got ill, she was sadly out of order, and had to have the doctor right away.—*From "Shooting and Fishing."*

USES OF A PIECE OF STRING.

A piece of string is often of great value to a hunter or fisherman. Stout string, such as is used to tie up heavy bundles, is most valuable. Some sportsmen put a piece of string at a higher value than any other single part of the camp outfit, apart, of course, from the implements of sport.

If the fishing rod breaks, the string mends it again. If the suspenders break, the string ties the ends together. Should the gun stock break, the string is invaluable. If a pack basket strap fails, a string takes its place. A tear in a tent is sewed up with string. Game is hung up out of reach of animals with string. A lost man makes snares out of string and catches birds and rabbits enough to keep him from going hungry; likewise a stout string will serve as a fish line in the absence of regular tackle. If the chain is lost, the dog may be led with a string. A boat can be anchored with a rock and cord.

In the absence of a string a substitute is made by cutting a strip as long as needed from a deer hide off which the hair has been taken. The woodsmen prefer a rawhide string to all others, because it is much stronger, if properly cut, and the woodsman is very expert in cutting the string of even strength. Where the hide is thin he cuts a broad strip; where it is thick he cuts a narrow one. He prefers horsehide to buckskin, and a buck's skin is better than a doe's.

A raft is easily made with a string and three or six logs, according to the size, and many a skin boat is sewed with rawhide strings. With a piece of string in his pocket no man need starve, or lack for sport, though lost and forty miles from anybody. He can break off a hemlock branch, make a bow, use a slender sapling for an arrow, and shoot his game as the Indians did. If he has a jackknife, so much the better, but the string alone will do. Fire may be started in an unravelled string by striking sparks into it from two hard rocks. A very important use of a string is stopping the flow of blood from a wound. A strip of bark, with a round stone to press into the artery, and a string to tie tight over the bark, has often been the means of saving a woodsman from bleeding to death.—*From The New York Sun.*

HOW TREATIES ARE MADE.

"The treaty-making power is given to the President, in connection with the Senate, by the Constitution. The initiative—the negotiations with foreign Governments leading up to an agreement, and the framing of the articles of the treaty—is with the executive. The Senate has no part in the matter until the President communicates the treaty to it, and asks its concurrence. It may then, however, either concur or reject, or concur with amendments. * * When the Executive has agreed with any foreign power upon a treaty, and it has been duly signed by the plenipotentiaries for their respective Governments, it is sent to the Senate for its concurrence, and is considered there in secret session. Whatever may be said as to the wisdom or necessity of secret sessions for other purposes it is manifestly necessary that the terms of treaties, and the discussion of them, should in many cases be kept in the confidence of those charged with concluding them, until they are concluded.

"Though all the attempts in the Constitutional convention to give the House of Representatives a part in the making of treaties failed, it is still true that many important treaty stipulations depend for their execution upon the action of the House. If a treaty stipulates for the payment of money by the United States the money cannot be taken from the treasury without an appropriation. It may be said that as a treaty is a part of the 'supreme law of the land,' it is the duty of Congress to appropriate the money necessary to carry it into effect; and that in the making of the appropriation the House has no right to consider the question of the value or propriety of the treaty. But, all the same, if the appropriation is not made the treaty fails. * * Usually appropriations to carry out a treaty have been given freely by the House; but there is a power to withhold them, and so to defeat the treaty. As to treaties involving our revenue laws, the House—having by the Constitution the sole power to originate revenue bills—has claimed the right to act upon the wisdom or unwisdom of the treaty."—*Ex-President Harrison in his "This Country of Ours" article in May Ladies' Home Journal.*

REALITY IS THE GREAT EDUCATOR.

Dr. Parkhurst asserts that "there is a certain keenness and vigor of discipline that can come to a man only as he lives out in the midst of things and becomes himself a part of the world and of the events with which the world is so solidly packed. Those to whom my words are particularly addressed are young men who are anxious to make themselves felt in the world, and to such it needs to be said that we best learn how to do by doing. A sense of opportunity, a feeling of being a part, even a minute part, of the machinery by which the threads of current event are being woven in, works upon us with the power of a fine discipline and a strong inspiration. The solidity of the burden that is carried helps to solidify the man who carries it. Problems tumble easily apart in the field that refuse to give up their secret in the study or even in the closet. Reality is what educates us, and reality never comes so close to us with all its powers of discipline as when we encounter it in action. In books we find truth in black and white, but in the onrush of event we see truth at work; and it is only when truth is busy, and when we are ourselves personally mixed up in its activities, that we learn to know of how much we are capable, or win the power by which those capabilities can be made over into effect. Let no young man, then, of spirit and purpose be dismayed by his inability to attend either college or university. Life is itself the oldest and best endowed university in the world, and will guarantee to its pupils all in the way of vigor, keenness and grasp that they have in them the grace and persistency to acquire."—*Rev. Charles H. Parkhurst, D. D., on "Substitutes for a College Training" in Ladies' Home Journal.*

INTERESTING FACTS REGARDING DIVERS.

The dress of a fully equipped diver weighs 120½ lbs., and costs about £100. First of all comes 8½ lbs. of thick under-clothing; then follows the dress itself, weighing 14 lbs., boots, 32 lbs., monstrous things with leaden soles; breast and back weights, 80 lbs.; and lastly, the helmet, which weighs 35 lbs. When the hull of the Great Eastern was cleaned by divers as she was being loaded with the cable for the Indian submarine telegraph the contract price for the work was £1,800, and it was completed in six weeks by twelve divers. The incrustation on her bottom was more that a foot thick and after it was removed she lifted fully two inches. The greatest depth at which a driver may safely work is 150 feet. There have been however rare instances of diving to 204 feet, and sustaining a pressure of 88½ lbs. on every square inch on the body of the diver. Diving was first incepted by the action of the elephant in crossing a deep river, when he swims beneath the water elevating his trunk by which method he breathes. The work of a diver consists in recovering lost articles, and slinging them in such a manner that they can be easily hauled up, cleaning and coppering ships' bottoms, cleaning propellers, and communicating by slate and voice. When able to work at a depth of 120 feet a diver is considered fully qualified. The flag ships in the British navy carry eight divers, and the cruisers four each, fully equipped.—*From the Strand Magazine.*

HISTORY IN A TREE.

In the British Museum of Natural History there is a section of the trunk of a large fir-tree from British Columbia, the growth rings of which indicate that it was more than 500 years old when it was cut down in 1885. The fact that about twenty of the annual rings of growth, marking the latter part of the first hundred years of the tree's existence, are crowded together in a remarkable manner, indicates that during these twenty years some cause was in operation greatly retarding the growth of the tree. On looking into history the correspondent found that, nearly at the time when the tree in question was evidently suffering from very adverse conditions, Asia and Europe were undergoing extraordinary disturbances from earthquakes, atmospheric convulsions, the failure of crops, pestilential diseases, etc. China, in particular, suffered even more than Europe. He therefore suggests that possibly the crowded rings in the trunk of the tree may be a record of the existence of the same unusual conditions affecting animal and vegetable life at that time in North America also; and he shows that if the tree had reached its full growth, and ceased to form new rings a few years before it was felled in 1885, the correspondence in time would be complete.—*From Nature.*

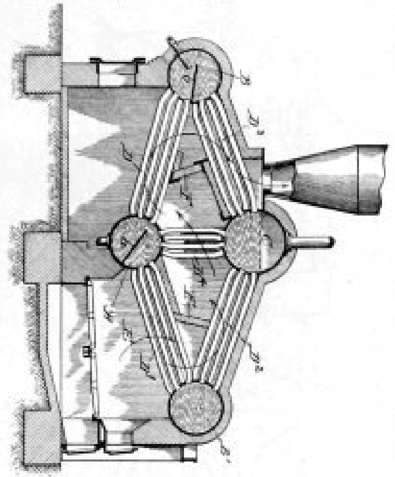
THE COLOR OF WATER.

The fact is generally known that pure water appears blue when light is transmitted through a sufficient thickness of it, and that when opaque particles are suspended in it the hue of the water is greenish. But while pure water looks blue when light passes freely through it, yet when it is contained in a deep, opaque receptacle, like the basin of a lake or the ocean, it ought to absorb all light and look black. Experience shows, however, that the deepest parts of the Mediterranean, for instance, appear not black, but intensely blue. This has been supposed to be caused by minute particles held in suspension, but the recent experiments of Professor Spring at Liege suggest a different explanation. He has found that warmer currents passing through pure water interrupt its transparency, even when the difference of temperature is very slight. Such currents may cause deep water to appear blue by reflecting light back from its depths through the transparent layers above. This, it is suggested, explains the fact that fresh water lakes are more transparent in winter than in summer, because in winter currents of heated water are not traversing them. Even the shadow of a mountain falling on a lake may increase the transparency of the water by cooling the surface.—*From The Youth's Companion.*

NEW INVENTIONS.

STEAM BOILER.

No. 556,697. JOHN E. SCHLIEPER, PITTSBURG, PA. *Patented March 17th, 1896.* This boiler consists of four transverse drums, connected by five sets of water tubes. The feed water is delivered into the "feed drum" *B*, under the plate *b*, which deflects it into the tubes *D*. The circulation currents move from *B* to the mud drum *A*, thence through the tubes D^1 to the front drum B', then through the tubes D^2 to the steam

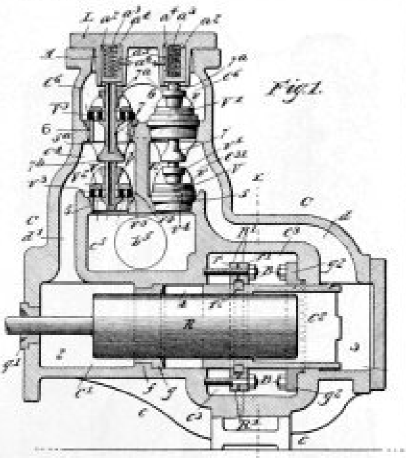


drum C. Here the steam and water separate, and the water continues down through the tubes D^3 to the feed drum. A part of the flow from the mud drum goes directly upward to the steam drum through the tubes D^4. The burning gases are compelled to travel crossways of all the tubes, by means of partitions *F* of fire brick. The course of the gases is shown by the arrows. A very effective application of the heat is thus secured.

PUMP.

No. 557,285. FRANK PEARN, MANCHESTER, ENGLAND. *Patented March 31st, 1896.* The view shown is a vertical section through one cylinder of a twin or duplex pump. The plunger *R* is double acting, being packed in the middle at 4. The gland is prolonged by a sleeve C^2, which projects into the back end 3 of the water cylinder, and is made water-tight by a gland g^2. The packing bolts *B* are accessible from the outside at all times. The main gland or sleeve may be removed at any time by pushing the plunger to the forward end of the stroke, and opening the joint between *c* and c^1, when either piece will come out sideways. The valves are

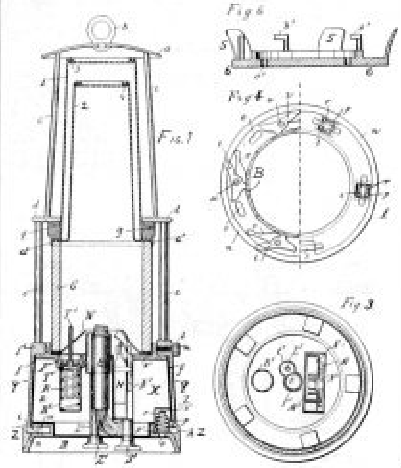
No. 557,285.



so arranged that all of them may be removed by taking off one cover *L*. There is no joint through which water can leak from the delivery side to the suction. The suction valves 5 will pass upward through the seat holes of the delivery valves 6, and collars on the lower end of the stems 7 serve as stops to limit the lift of the suction valves. The valve seats are fitted into taper holes and are pressed home water-tight by the water pressure.

SAFETY LAMP.

No. 557,548. KAREL BROUCEK, M. OSTRAVA, AUSTRIA. *Patented April 7th, 1896.* Fig. 1 is a vertical section of the lamp; Fig. 3 is a cross section on the line *Y Y* of Fig. 1; Fig. 4 is a section on the line *Z Z* of the same; and Fig. 6 is a section across the unlocking tool. This lamp is constructed to burn benzine, but can be easily adapted to burn kerosene if desired. The wick may be round, flat or tubular. The upper part of the lamp is provided with two gauze cylinders *1* and *2*. These are flanged outwardly at *a'*, and are held tightly against the end of the glass cylinder by means of a coiled spring *g*, which is held in place by the middle ring *d*. The lower end of the glass cylinder rests upon the flange of the cone *W*, which surrounds the burner. The wick is secured to a short sliding tube *t* which can be moved up or down by the screw *Z'*. The wick is ignited by means of an exploder *N*, which is loaded with a coil of detonating material. The igniter is operated by pulling down the knob *S'*. The lamp front *X* is removable from the lamp base *f*, and is secured in place by a lock



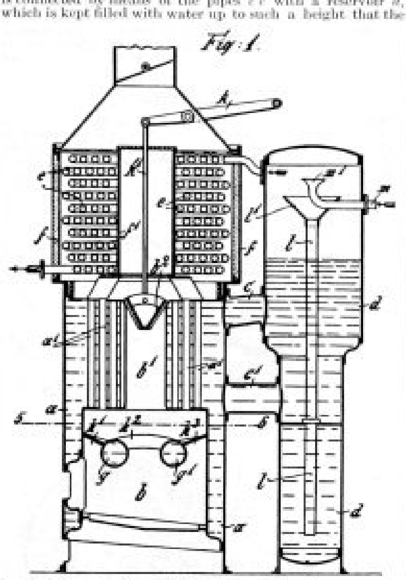
ring *R*. This ring is provided with a number of spring latches *i*, which catch into notches in the lamp base. The lamp front cannot be removed except with the aid of the tool shown in Fig. 6. This consists of a ring having several lugs 5, by which it may be turned, and also a number of pins *U*, which are adapted to enter the holes *o*, in the lock ring *R*. By turning the ring 6, the pins operate to open all the latches *i* simultaneously, and thus unfastens the ring and releases the lamp front. *T* is a filling tube, provided with a spring-closed valve, by means of which the fount may be filled, when detached, without permitting the vapor of the benzine to escape into the air.

SUPERHEATING STEAM BOILER.

No. 558,210. WILHELM SCHMIDT AND GUSTAV HENKEL, WILHELMSHOHE, GERMANY. *Patented April 14th, 1896.* This boiler is designed for the rapid and economical production of highly superheated steam.

Referring to Fig. 1, *a* is the boiler, and *a'* the heating-tubes of the same. Said tubes are arranged around a large central flue *b'* extending upward from the furnace *b*. Said flue may partly or wholly be closed by a lid or cover b^2. The boiler *a* is connected by means of the pipes *c c'* with a reservoir *d*, which is kept filled with water up to such a height that the

Fig. 1.

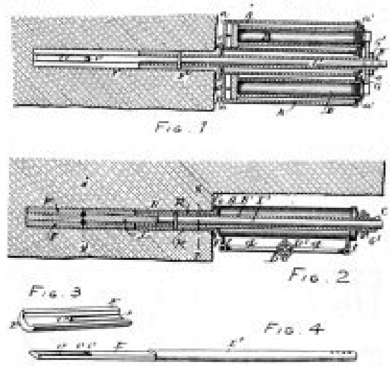


level of the water is constantly higher than the upper ends of the heating-tubes *a'*. The latter are therefore constantly surrounded by water throughout their whole length, and are secured against burning.

The superheater *e* consists of a series of horizontal coils arranged above the boiler *a* and between an outer casing *f* and an inner casing *f'*. One end of said superheater is connected with the dome of the reservoir *d*. The steam escaping from the latter and flowing through the coils of the superheater *e* is superheated by the furnace-gases passing either through the heating-tubes *a'* only or through the flue *b'*. If the latter is closed by the lid or cover b^2, the fire-gases will be comparatively much exhausted by the large area of surface offered by the heating-tubes, and the degree of superheating will thus be less than if a smaller or greater portion of said gases is allowed to escape through the flue *b'*. There is thus afforded a means of regulating the degree of superheating of the steam.

MINING WEDGE.

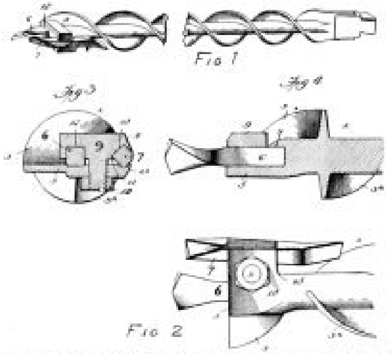
No. 557,143. WILLIAM A. MCKINLAY, DENVER, COLO. *Patented March 31st, 1896.* Fig. 1 is a top view, in section of the machine in place; Fig. 2 is a sectional side view of the same; Fig. 3 is a perspective view of one of the shells; and Fig. 4 shows the central wedge and rod. A section through the wedge *I*, and the shells *F*, is shown in Fig. 2. Small rollers are interposed between them, and when the rod *I'* is pulled outwards, they roll forward between the inclined surfaces of *I* and *F*, and spread the shells apart with great force. The



necessary power to operate the wedge is applied by means of two cylinders *A*, and pistons *B*, which are coupled to a cross-head *G*, to which the rod *I'* is also attached. The rear ends of the cylinders rest against tubular blocks or distance pieces *R*, which extend to the shells *F*. To use the machine it is inserted in the drill hole, with all the parts in the position shown in Fig. 2; water is then pumped into the cylinders *A*, forcing the pistons *B* outward, thus pulling the bar *I* forward and forcing the shells apart. The machine is very compact, and in practice it supports itself without any additional post or bar.

COAL AUGER.

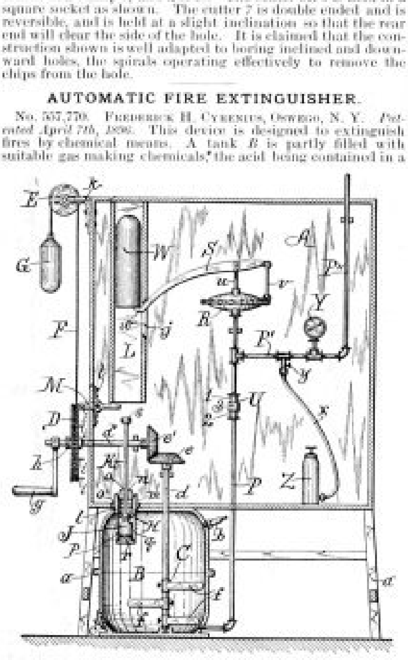
No. 558,204. JOHN T. SNYDER, LUZERNE, PENNA. *Patented April 28th, 1896.* Fig. 1 shows the auger complete; Fig. 2 is an enlarged view of the end of auger; Fig. 3 is a cross section through the bit clamps; and Fig. 4 is a section along the center line. The body of the auger is made with a double twist and a central core. The cutting end is provided with



two removable cutters, 6 and 7, which are held in place by means of a clamp 9, and nut 10. The center bit 6 is held in a square socket as shown. The cutter 7 is double ended and is reversible, and is held at a slight inclination so that the rear end will clear the side of the hole. It is claimed that the construction shown is well adapted to boring inclined and downward holes, the spirals operating effectively to remove the chips from the hole.

AUTOMATIC FIRE EXTINGUISHER.

No. 557,770. FREDERICK H. CYRENIUS, OSWEGO, N. Y. *Patented April 7th, 1896.* This device is designed to extinguish fires by chemical means. A tank *B* is partly filled with suitable gas making chemicals, the acid being contained in a

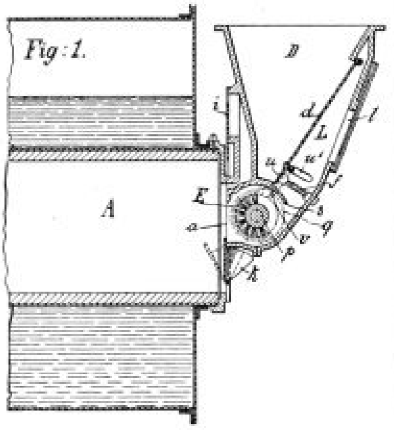


glass bottle *J*. The premises to be protected are provided with a series of pipes and "fusion valves" similar to the automatic sprinklers now in common use for fire protection.

The pipes are filled with compressed air. At *U* there is a washer of thin sheet lead which cuts off the compressed air from the tank *R*. When the temperature rises above 100° at any of the fusion valves, the valve opens and allows the air to escape. The diaphragm in the case *R* falls and lowers the lever *S*, thus liberating the weight *W*. When the weight falls it strikes the pin *K*, and smashes the acid bottle *J*, thus mingling the acid with the other chemicals, and starting the formation of gas. The weight also trips the latch *M* and frees the wheel *D*; the weight *G* runs down, and the cord *F* turns the wheel *D*, and the agitator *C* stirs up the materials in *B*. As soon as the gas pressure rises to the proper degree it bursts the lead washer in *U*, and the contents of *B*, both liquid and gaseous pass into the pipe system and are ejected from the valve which was unseated by the heat.

APPARATUS FOR BURNING COAL DUST.

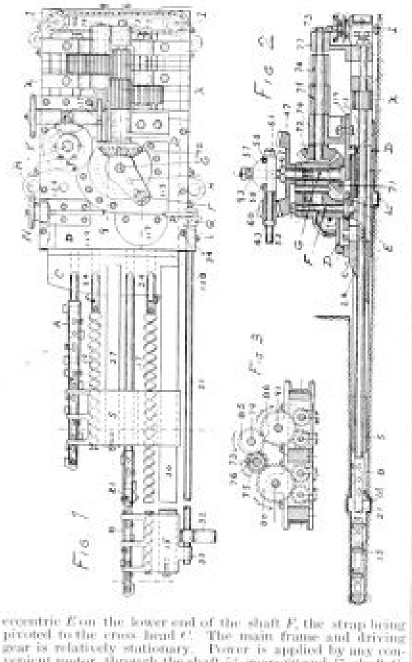
No. 558,875. George Hillinger, Berlin, Germany. *Patented April 21st, 1896.* The drawing shows the apparatus attached to the furnace *A*, of an internally fired boiler. The ground coal is fed into a hopper *D*. No particular pains need be taken to have the fuel very dry, because all lumps are broken up by means of a vibrating shutter *d*, which is opened



by a cam tooth on the shaft *p*, and closed with a shock by the spring *f*. The material which passes by the shutter falls to the under side of the revolving brush *E*, and is projected by it through the opening *a* into the furnace. No grates are used. The necessary air for combustion is admitted through the damper *h*. The brush is made of steel wires, which are so elastic that they throw the fine fuel a sufficient distance into the furnace to ensure its proper combustion.

MINING MACHINE.

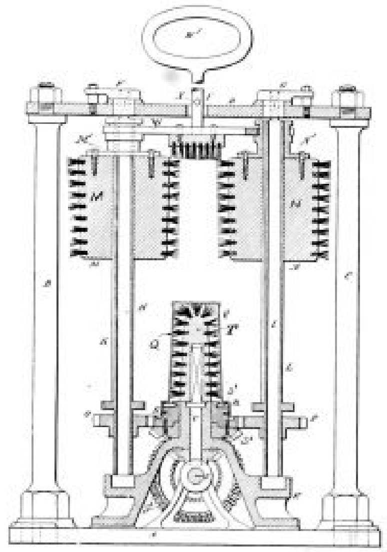
No. 557,340. Charles O. Palmer, Cleveland, Ohio. *Patented March 31st, 1896.* Fig. 1 is a top view of the machine; Fig. 2 is a longitudinal section of the same, and Fig. 3 is a cross-section on the line *x x*. This machine employs two revolving cutter bars *A* and *B*, which are forced sideways against the coal. They revolve in opposite directions, so that the tendency to deviate from a straight line in cutting is obviated. Spiral conveyors 17 and 19 are placed behind the cutter bars to remove the chips out of the kerf. The outer ends of the cutter bars are supported in bearings 3 and 15. The whole frame which supports the cutter bars and conveyors is vibrated in and out while at work, by means of an



eccentric *E* on the lower end of the shaft *F*, the strap being pivoted to the cross head *C*. The main frame and driving gear is relatively stationary. Power is applied by any convenient motor, through the shaft 53, gears 69 and 47, shaft 61, gears 71 and 72, and the train of spur gearing shown in Figs. 1 and 3. The machine is fed forward by means of a rope and the windlass *J*, which is operated by means of a ratchet wheel 135 and a worm *K*. The ratchet is turned slowly by means of a pawl, which is mounted on the reciprocating frame. The machine is guided by means of blocks which are fastened in the eyes *H*, and which engage the groove *L* in the floor. The cutter bar *B* is provided with an extra long tooth 27, which serves to cut a guide groove *M* similar to *L*, for the next cut. The point of the cutter bars may be forced up or down by means of the arm 52 on the rock shaft 51. The position of the arm is controlled by the hand wheel *N*, through the rod *P* and arm *Q*.

SAFETY LAMP CLEANER.

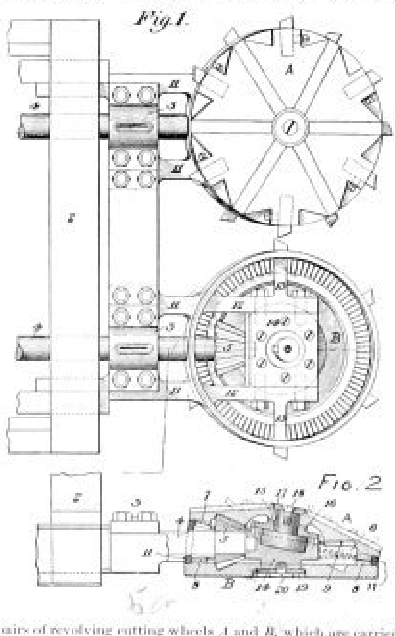
No. 559,171. Gottfried Grossman, Dortmund, Germany. *Patented April 28th, 1896.* The object of this invention is to clean the wire gauze cylinders of safety lamps thoroughly and quickly, without injuring or deforming them. The machine contains three rotary brushes *T*, *M* and *N*, all of which may be rotated simultaneously, by means of a crank on the end of the shaft *V*. The gauze cylinder *Q* is cleaned internally by the brush *T*, and is then secured to the hub of



the wheel *S*, by means of a clamp ring *S'* and a rubber washer *R*. The two brushes *M* and *N* are then moved downward by means of the yoke plate *W* and handles *W'*. Motion is communicated from the central wheel *S* to the shafts *H* and *I*, by the pinions *P* and *O*. As the gauze is turned by the wheel *S*, the brushes *M* and *N* operate on all parts of its circumference. The shafts *H* and *I* can be adjusted to compensate for the wear of the brushes, and to suit the shape of the gauze cylinder.

MINING MACHINE.

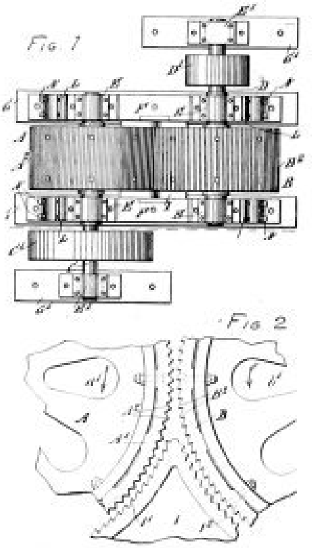
No. 557,745. C. E. Wolfendale and G. W. Fritz, Pittsburg, Pa. *Patented April 7th, 1896.* This is an improvement on the machine shown in Patent No. 536,912, which was described in The Colliery Engineer and Metal Miner of June, 1895. Fig. 1 is a top view, one of the top cutter wheels being removed, and Fig. 2 is a vertical section through a pair of cutter wheels. The under cutting is done by means of two



pairs of revolving cutting wheels *A* and *B*, which are carried on the front end of the machine, and are forced against the coal by suitable feeding apparatus. Each pair of wheels are geared together by means of teeth 7 and 8, and the upper wheel is driven by the shaft 4, pinion 5 and gear teeth 9. The gearing is protected from the entrance of dirt by the shield 17 which encloses them. The cutters, which are inserted in the edge of the wheels, cut a kerf extending across the entire front of the machine, and provide ample clearance for the sliding frame and driving mechanism. Both pairs of wheels deliver their chips well to the rear.

COAL GRINDER.

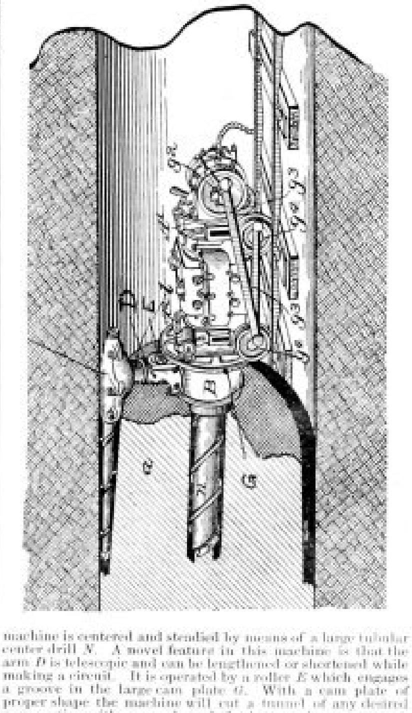
No. 559,272. Samuel Evans and F. J. Morgan, Elkhorn, W. Va. *Patented April 28th, 1896.* This machine is designed to disintegrate bituminous coal and prepare it for coking. Fig. 1 is a top view of a pair of grinding rolls; and Fig. 2 is a sectional view of a part of the grinding surfaces. The rolls *A* and *B* turn at different speeds, *A* being the slow roll. The grinding surfaces on both rolls are grooved, the grooves being



inclined at a small angle to the axis. The grooves on *A* are V shaped, while those on *B* are ratchet shaped. The coal which passes between the rolls is further ground against the stationary block *I*, which also is provided on its working faces with grooves of a similar kind. The grinding surfaces are made in segments, which are attached to the roll bodies by bolts, so as to be easily removed when worn or broken.

TUNNELING MACHINE.

No. 556,985. Frederick Hurd, London, England. *Patented March 24th, 1896.* The drawing shows the machine at work cutting a tunnel. The working parts of the machine are similar to those described in patent No. 556,986 shown in The Colliery Engineer and Metal Miner for June, 1896. In this machine the cutter bar is mounted at the outer end of an arm *D*, which, together with the head *E*, can be swung in a complete circle, thus cutting around a core piece *A*. The



machine is centered and steadied by means of a large tubular center drill *N*. A novel feature in this machine is that the arm *D* is telescopic and can be lengthened or shortened while making a circuit. It is operated by a roller *E* which engages a groove in the large cam plate *G*. With a cam plate of proper shape the machine will cut a tunnel of any desired cross-section, either round, oval, flat-bottomed or square. A machine of the same general construction is made for boring vertical shafts, etc.