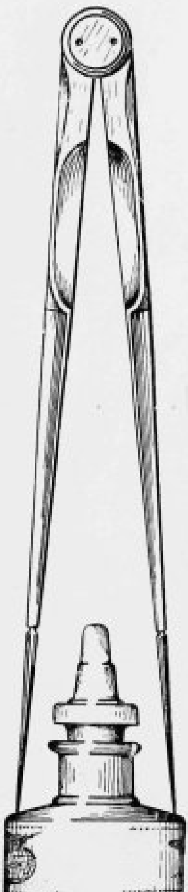
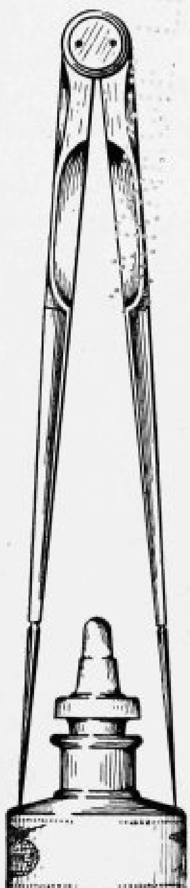
The Draftsman.



VOLUME III.

January - December
1904.



W. D. BROWNING, - PUBLISHER
CLEVELAND, OHIO.
1904.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

The Draftsman

Devoted to Drafting, Illustrating and Home Study.

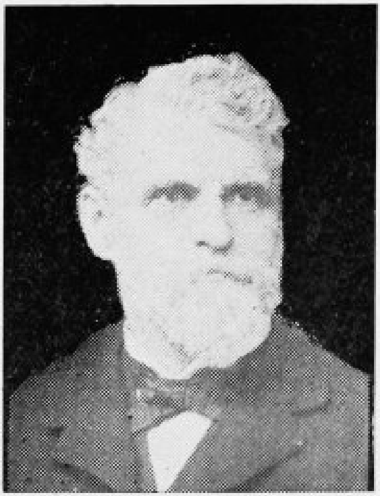
PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Mr. Ambrose Swasey, the New President of the A. S. M. E.

Honord here and wears a Cross of Legion of Honor.

MR. Ambrose Swasey of Cleveland was recently elected president of the American Society of Mechanical Engineers at their New York meeting.

Since the society is one of the leading organizations of its kind in the world, embracing the foremost engineers of this country it is deemed an honor to be at its head and Mr Swasey is the second Cleveland man to attain it in the past two years,



Mr. Swasey's predecessors in the chair of president have been such men as Admiral Melville of the United States Navy, and the late Prof. Thusrton of Cornell University.

Mr. Swasey is a member of the well known firm of Warner & Swasey Company and is recognized in the United States and Europe as the most eminent authority on the telescope and sidereal astronomy.

He designed and build both the Lick and the Yerkes telescopes and his firm has constructed most of the great telescopes of this country and Europe in the last twenty years.

The firm is also well known as machine tool builders, of lathes mainly.

In 1901, Mr. Swasey was decorated with the cross of the Legion of Honor by the president of France, being one of the few men in the United States to be so honored.

MECHANICAL.

Dimensioning Drawings,

THE angle of the dimension line has much to do with the arrangement of the figures, but in all cases the figures should be placed so to read from the right and bottom sides of the drawing.

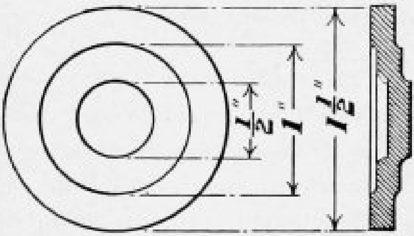


Fig. 3.

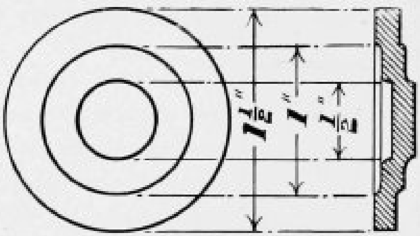


Fig. 4.

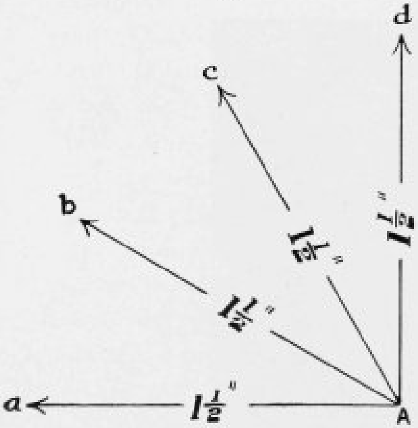


Fig. 1.

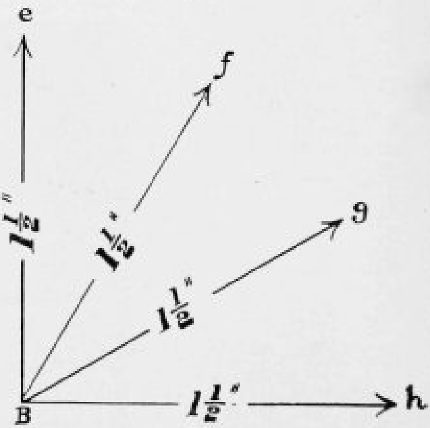


Fig. 2.

In Fig. 1, a lot of lines are drawn in to illustrate the effect of angularity of the figures, although that one on line *Ad* has been reversed.

In Fig. 2, the figures are read much more easily, and if the figures were placed as on line *Bh*, they would finally be vertical on line *Bc* instead of as shown.

It would probably be best to place the figures on *Ac* the same as *Ad* as it would be more easily read than as it is now, even if the sheet was not turned from right to left, as is often done in reading a drawing.

Then figures on lines that run and to the left at a greater angle than 30° should be turned the same as on *Ad*, so as to read from the right side. Figures should not be set to one side of the dimension line, but a space allowed in the line for them, for the figure is what the workman wants, not the line.

Dimension lines are often carried across the projection lines, as in Fig. 4; this is a poor way, the neater form being shown in Fig. 3.

Very little thought is given to these matters by many draftsmen, and it is to be regretted, too, though there may be an extreme in such things, that is, carrying it too far and wasting time trying to be artistic.

Projecting Curves in Drawing.

THERE is often a doubt in the mind of the draftsman as to what points should be projected from view to view on a drawing, and sometimes one finds a circle or other line put in to show something which readily does not exist in the other view.

To illustrate, in Fig. 1, we have two views of a cast iron washer with the front view showing two curves intersecting, and the question is should there be a circle in the top view to show their intersection?

The front view in Fig. 2 shows the curves coming together different than in Fig. 1, the line of centers of the curves being at right angles to the projecting lines to the *top* view.

If we project the point of tangency in Fig. 1, it would be perpendicular to *CC*, but this would not be parallel to the projection lines of the views, hence could not touch the top view in the part where the curve really exists.

Again, there would be no horizontal line in the front view from points of tangency, as shown in Fig. 2, for here we have two curves intersecting at a point in their center line, which is perpendicular to the horizontal lines of the object. Then there would be no line in the top view to show point *a*, but there would be a horizontal line as shown.

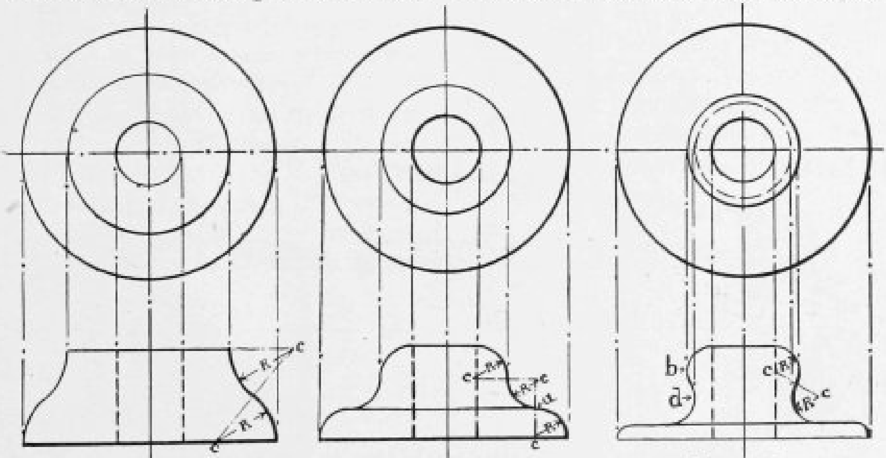


Fig. 1. Fig. 2. Fig. 3.

The next case is illustrated in Fig. 3; two curves, one under cutting so that their point of tangency cannot be projected any more than in Fig. 1.

Here the under cut surface would have to be located in the top view as any limiting point in a surface should be, and in this case it will show dotted in that view.

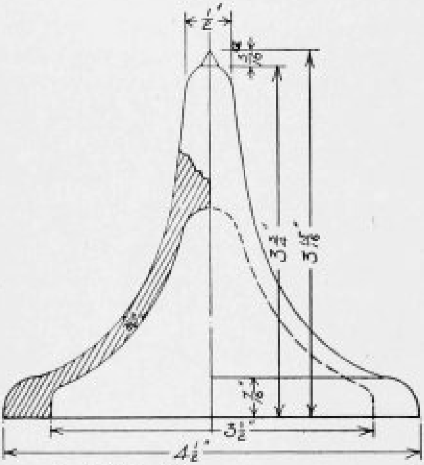
Only the part of the curves b and a would be shown, also a horizontal line is put in the front view.

Then the intersection of curves in the front view are projected to the top if the line of centers is perpendicular to the projection lines of the object.

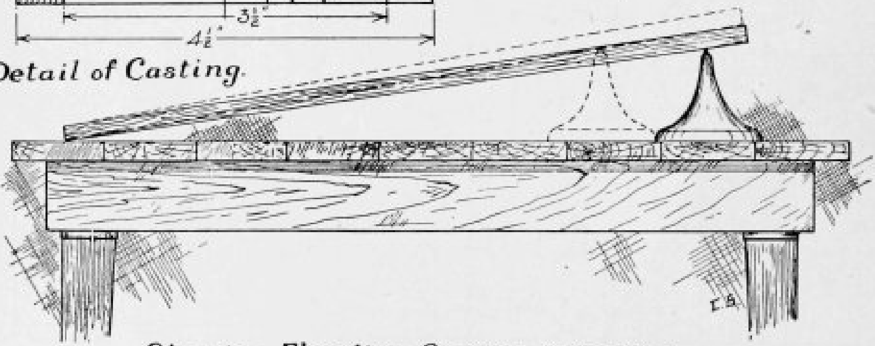
Drafting Board Elevating Casting.

To those who use flat drawing tables, the casting illustrated in the accompanying sketch will be found very useful. By placing two or more castings under the boards at the rear almost any angle may be obtained. The point may be ground up sharp, thus giving the holder a firm grip on the board.

ARTHUR B. BABBITT,
Hartford Public High School,
Hartford, Conn.



Detail of Casting.



Showing Elevating Casting in position.

"Sold by the Shock."

A farmer went on a visit to a friend. After dinner the husbandman requested to be shown round the town.

After visiting several places they finally reached the electric lighting works.

"What d'ye call this place, Dan?" queried the farmer.

"This is called the electric plant," was the reply.

"Plant! What do they grow?"

"They grow currents."

"How do they sell 'em—by the bushel?"

"They don't sell 'em by the bushel; they sell 'em by the shock."—Stray Stories.

The Use of Fillets.

BY R. T. STROHM.

THERE are numerous, almost innumerable, instances in the designing of machinery where a change of contour or of size forms an angle in the work, and, wherever it is possible to do so, a generous fillet should be used. That is, instead of allowing sharp corners or angles in castings or in machine work where a sudden increase in diameter forms a shoulder, the angle should be filled in, or rounded so as to make a gradual blending of one surface into the other.

This rounding of angles serves a double purpose. First, it improves the appearance of the piece, and hence it is to be commended, when viewed from an artistic standpoint. But what is of more consequence to the designer, the builder, and the user, it makes the piece considerably stronger and less liable to injury than if it were left with a sharp angle at the junction of the surfaces.

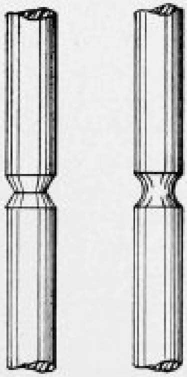


Fig. 1. *Fig. 2.*

Anyone who has ever observed a blacksmith at work has doubtless noted the method he pursues in cutting off a piece of bar iron. He simply heats it to a red heat at the point where it is to be cut, nicks it on the hardie, quenches it quickly and lays it on the anvil so that the nick comes directly above the edge of the anvil. A light blow on the projecting end is sufficient to break the piece, along the line of the nick.

It is true that the bar has been weakened on account of the depth of the nick, since the area of cross-section of the bar at that point is decreased. Yet, if a plain bar of the same sectional area as the section at the nick had been similarly heated and quenched, it would not have broken under repeated blows, but would have simply bent over at an angle. The conclusion arrived at, therefore, is that the angle formed by the hardie has caused an element of weakness in the bar.

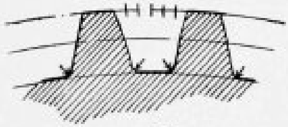


Fig. 3.

The same reasoning holds true in all similar cases, and the conclusions may be corroborated and strengthened in a number of ways. Let two bars of the same material, say steel, be turned accurately so as to form test pieces, as in Figs. 1 and 2. Let the first be cut with an angular groove, so that the diameter at the bottom of the cut is one inch. Let the other be made with a rounded groove of the same depth as the angular groove in the first bar, and let the bars be exactly alike, in form and dimensions, in all other respects. Theoretically, since the bars are of the same material, and homogeneous, and since they have exactly the same area of cross-section at their weakest points, they should sustain the same load. But if they are subjected to stress in a testing machine, it will be found that the second, shown in Fig. 2, is by far the stronger of the two.

A very ordinary illustration of this is to be found in the case of a common threaded bolt subject to tension. Theoretically, to withstand a given load, the weakest section, or the section at the root of the thread, would need to be of an area equal to the total load on the bolt divided by the safe tensile strength, per square inch, of the material. In actual work, however, the root area must be somewhat larger than this; or, in other words, a smaller value of the safe fibre stress must be taken. For, the metal at the root of the thread is weakened by the crushing effect of the point of the thread-cutting tool, in forming the thread; and further than that, the sharp angle at which the thread surfaces meet constitutes an added cause of weakness.

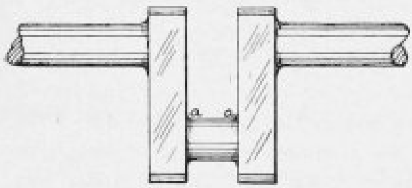


Fig. 4.

It makes no diference whether the piece is to be subjected to steady or to sudden tensile or transverse stresses. The use of a fillet at the angle will make it considerably stronger, and, within reasonabel limits, the more generous the fillet the greater the strength of the part at that point. A few examples of cases in which the fillet is of great value may be cited.

The teeth of gear wheels, especially of large cast gears, are frequently subjected to great shocks in operation. At its best cast iron is not very strong when in tension or flexure. Consequently, to insure strength and freedom from breakage, the teeth are joined to the rim of the gear wheel by fillets, the radius of which is usually made equal to one-sixth the width of the space between two adjacent teeth, measured at the circumference of the addendum circle, as shown in Fig. 3.

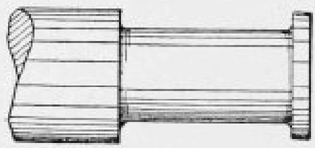


Fig. 5.

The crank shafts of steam engines are also liable to be subjected to shocks and must sustain a considerable bending moment also. When the crank is forged, as illustrated in Fig. 4, the crank-pin is given fillets at *a, a,* where it joins the cranks, to prevent any possibility of cracks starting at those points, due to the bending and twisting, a thing which might easily occur if a sharp corner were used instead. The same is true of the junction of the cranks and the shaft.

The journals of railway car axles and similar axles on street cars are subject to repeated shocks under transverse stresses, and we find them constructed as in Fig. 5, with good fillets at the shoulders. And so the number and diversity of illustrations might be indefinitely multiplied.

The methods of obtaining the fillet are various. Formerly the corner was rounded by cutting the material of the pattern, in making patterns for castings, or by using beeswax, which can be easily molded or pressed into the desired shape. Of late, however, fillets of wood, leather and metal have been manufactured and extensively used. The wooden fillets are simply strips of wood, square or triangular in cross-section, which are glued into angles between surfaces and then hollowed out to the proper curvature. Obviously, the wooden strip cannot be easily applied to any other than plane surfaces. The leather and the metal fillets, however, which are put up in bundles of strips, each strip being four feet long, may be readily fixed to irregular surfaces of almost any degree of curvature. The leather fillet is glued in place and is sold in various sizes, according to the radius of the fillet required. The metal fillet is held in place by small nails or tongues, and is answers its purpose well. But it has the disadvantage that rough usage of the pattern may cause it to jar loose from its fastenings.

Mine Ventilation, Past and Present.

BY CHAS. KUDERER, MONONGAHELA, PA.

THE subject of mine ventilation is a matter of growing and vital importance. Mining operations have to-day developed into such a wonderful magnitude that the problem now confronting us is the proper means by which mines can be ventilated. In the earlier days of mining operation four to five thousand cubic feet of air circulated through the workings of a mine was considered sufficient. At the present day many of our mines require a circulation of from 45,000 to 65,000 cubic feet of fresh air per minute. This great volume of air must be generated from the atmosphere by powerful positive acting centrifugal ventilators.

The earliest type of mine ventilator was known as the wind cowl, by which the pressure of the wind at the surface was brought to bear effectively upon the mine air-ways by the action of a cowl whose mouth could be turned toward the wind. This was naturally very unreliable. The waterfall was also extensively applied at one time, but its application could only be made where there was a reliable source of water supply and where the drainage of the mine could be effected through a tunnel, or where the mine opening could be placed in connection with the waterfall outside the mine. Where these conditions are obtained, as is the case in some mountainous districts, the waterfall is still in use, as it is an effective means of ventilation and economical. Its application, however, is limited to the ventilation of small mines.

The foregoing methods of ventilation eventually give way to furnace ventilators. The furnace being placed at the bottom of the up-cast shaft where attended and continually fired by fuel furnished from the pit, the heat issuing from the furnace ascending into the up-cast shaft, thus heating the air therein, causing a difference in weight between equal volumes of air between the up-cast and down-cast shafts. This method, though effective in ventilation, was dangerous and at times unreliable. In case of mine explosions the furnace being placed at great depths in the bottom of the mine, would become useless and dangerous, setting fire to the mine. As mining operations have progressed step by step, better and more positive methods of mine ventilation became necessary to supply the demand of the present age of modern mining engineering.

The foregoing methods are to-day only examples for comparison and are surpassed by modern mechanical force of exhaust steel mine ventilators. A large number of mechanical mine ventilators are patented and applied to mine ventilation with more or less success, commencing with the Nasmyth ventilator as early as 1847, to the improved type of ventilator of the present day. During all these years of experience with mechanical ventilators we have developed into distinct classes as follows:

Class 1—*Open Running Ventilators.*

Discharging air from the wheel around the entire circumference directly into the atmosphere.

Class 2—*Closed Running Ventilators.*

The wheels revolving in a closed casing and discharging the air through an open discharge orifice.

Class 3—*Force Fans.*

Taking the fresh air from the atmosphere and forcing it by compression into the down shaft through the workings of the mine and out into the atmosphere through the up-cast.

Class 4—*Exhaust Fans.*

Exhausing foul air from the mine by vacuum, the fresh air entering the mine through the down-cast, passing through the workings of the mine and finally exhausting into the atmosphere through the up-cast.

Class 5—*Centrifugal Ventilators.*

Having blades or vanes set at right angles to the plane of rotation of the wheel; the air as it enters the wheel through the intakes passes through the wheel and is then discharged at the tips of blades by centrifugal force.

The most modern and highly efficient ventilators of the present day have the following principles embodied in their construction:

1—Double intake ventilator.

2—Closed spiral casing.

3—Deflecting center cone.

4—Blades or vanes radiating from the tips inward toward center of wheel a proper distance, then diverging into a curve tangent to the throat circle.

5—Reversible force or exhaust.

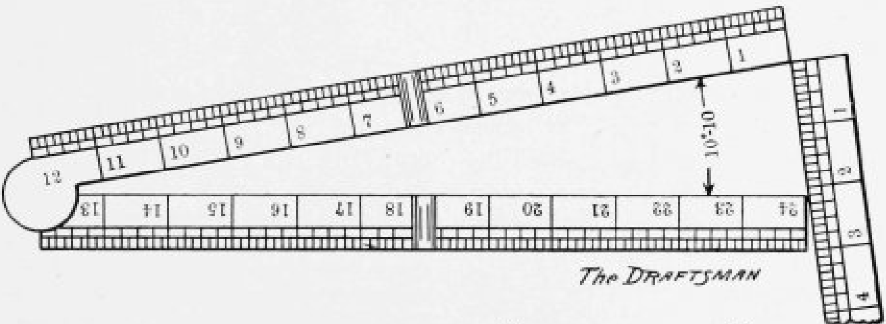
6—Impelling intake fans such as have flat surfaces set at angles to axis of shaft impelling the air as it passes through the intakes.

The Measurement of Angles by the Opening of a Two-foot Rule.

BY P. ENDRIVER

IT OFTEN happens that the draftsman or mechanic desires to lay out a given angle, or to measure an unknown angle, and no protractor is at hand.

In such a case the measurement may be made very approximately by the use of an ordinary two-foot rule as shown in the accompanying sketch. The table herewith gives the angle of openings up to 90 degrees and for measurements by 8ths up to 17 inches, the opening nearest to 90 degrees.



For any angle not given the opening may be determined by the following formula:

Opening=24×Sin ½ angle and conversely,

$$\text{Sin } \tfrac{1}{2} \text{ angle} = \frac{\text{Opening}}{24}$$

As an example of the application of this formula we will suppose we wish to lay out an angle of 40 degrees

Then: Opening=24×Sin 20°

Opening=24×.3420

Opening=8.208 inches

Having an opening of 15⅜ inches, required, the angle

$$\text{Sin } \tfrac{1}{2} \text{ angle} = \frac{15.375}{24}$$

Sin ½ angle=.6406

½ angle=39°—50′

Angle=2×39°—50′

Angle= 79°—10′.

Table of Angles Corresponding t Openings of a Two-foot Rule.

In.	Deg's.	Min.	In.	Deg's.	Min.
⅛			4⅜	21	00
¼	1	12	4½	21	37
⅜	1	48	4⅝	22	13
½	2	24	4¾	22	50
⅝	3	00	4⅞	23	27
¾	3	36	5	24	03
⅞	4	11	5⅛	24	39
1	4	47	5¼	25	16
1⅛	5	23	5⅜	25	53
1¼	5	58	5½	26	30
1⅜	6	34	5⅝	27	07
1½	7	10	5¾	27	44
1⅝	7	46	5⅞	28	21
1¾	8	22	6	28	58
1⅞	8	58	6⅛	29	35
2	9	34	6¼	30	11
2⅛	10	10	6⅜	30	49
2¼	10	46	6½	31	26
2⅜	11	22	6⅝	32	03
2½	11	58	6¾	32	40
2⅝	12	34	6⅞	33	17
2¾	13	10	7	33	54
2⅞	13	46	7⅛	34	33

3	14	22	7¼	35	10	10⅛	49	54	14⅜	73	36
3⅛	14	58	7⅜	35	47	10¼	50	34	14½	74	21
3¼	15	34	7½	36	25	10⅜	51	13	14⅝	75	06
3⅜	16	10	7⅝	37	03	10½	51	53	14¾	75	51
3½	16	46	7¾	37	41	10⅝	52	33	14⅞	76	36
3⅝	17	22	7⅞	38	19	10¾	53	13	15	77	22
3¾	17	59	8	38	57	10⅞	53	53	15⅛	78	08
3⅞	18	35	8⅛	39	35	11	54	34	15¼	78	54
4	19	12	8¼	40	13	11⅛	55	14	15⅜	79	40
4⅛	19	48	8⅜	40	51	11¼	55	55	15½	80	27
4¼	20	24	8½	41	29	11⅜	56	35	15⅝	81	14
8⅝	42	07	12⅞	64	53	11½	57	16	15¾	82	02
8¾	42	46	13	65	35	11⅝	57	57	15⅞	82	49
8⅞	43	24	13⅛	66	18	11¾	58	38	16	83	37
9	44	03	13¼	67	01	11⅞	59	19	16⅛	84	26
9⅛	44	42	13⅜	67	44	12	60	00	16¼	85	14
9¼	45	21	13½	68	28	12⅛	60	41	16⅜	86	03
9⅜	45	59	13⅝	69	12	12¼	61	23	16½	86	52
9½	46	38	13¾	69	55	12⅜	62	05	16⅝	87	41
9⅝	47	17	13⅞	70	38	12½	62	47	16¾	88	31
9¾	47	56	14	71	22	12⅝	63	28	16⅞	89	21
9⅞	48	35	14⅛	72	06	12¾	64	11	17	90	12
10	49	15	14¼	72	51						

The Valuable Man in the Shop.

BY GEORGE E. WALSH.

THE modern shop is essentially different from that of a quarter of a century ago, and the tendency to manufacture as cheaply as possible by means of machinery is rapidly abolishing hand work, and the workmen are becoming more and more limited specialists. The modern complicated machines require skilled operators to run them, but their construction and repair are more important from the point of view of the shop workers. There is a good deal of detail work that must be performed by very accurate hands and eyes. No machinery can do this, and unless the workmen are skilled in handling the file, scraper, cold chisel and hammer difficulties must follow.

The young men learning the trades to-day are in danger of overlooking the necessity of becoming intimately acquainted with the handling of all sorts of tools. In the old shops a journeyman or apprentice had to be a good deal of "a jack of all trades." He learned every feature of the business. He probably had to solve more knotty problems in the course of a year than the workmen of to-day would stumble across in ten years. In learning the trade to-day the apprentice in a machine shop depends so much upon machinery to do the accurate detail work that he fails to get the all-round skill and education that makes him a most valuable man in the future. The machinist or tool maker who can do accurate hand work is becoming a rarer product of our schools and shops each year. The modern tendency is not to teach him to handle chisel and file to finish off with almost the accuracy of a machine the little jobs that were formerly a part of the regular shop practice.

Yet the valuable man of the future shops must of necessity be one who has had this drill, and who, instead of abandoning good hand work because machinery has come to his aid, keeps up the old-time practice for the love of it. The complicated machinery of to-day will soon require expert hand workers. In the repair shop this will be particularly true. The call from many of the large railroad repair shops in the past few years has been for men of this character. The old-time shopmen who were taught their trade so thoroughly are the most in demand. The very familiarity they have had with the tools of common use has made them self-reliant. They have learned to solve knotty problems which the modern worker is apt to approach with misgivings. The imagination after all plays a part in shop work. It requires one to see through the imagination that some possible trouble in the machinery is causing the breakdown. The man without any imagination or training to look for the trouble in the most likely place is apt to find himself helpless before a job which another could easily solve.

It is not true that all shops turn out apprentices and journeymen of this character. Some of the modern ones drill their workmen in all the detail hand work that will help to make them of value. The men must spend some of their time at the vise with file and hammer for hours at a stretch. They are not finished workmen until they can do as fine a piece of labor with file or hammer as machinery could do. The man who can go down in the wheel-pit with chisel and hammer, and by the light of a tallow candle chip a keyway in a jack shaft is worth more in an emergency than a dozen who know nothing about such kind of work. The average workmen of today dislike to chip away a slot on some line of shafting where there is scarcely room to swing a hammer. But such work must be done at times, and no shop can get along without men who can do it.

The man who can do useful hand jobs around a shop is thus one of the most valuable and indispensable today. Even if machinery has displaced much of the work that was formerly done by hand, we cannot afford to neglect this side of the shop life. The modern technical schools have heretofore proved accurate in their theoretical teaching, but this sort of education must be supplemented by the practical side. Some of them are revising their practice in appreciation of this. Instead of simply teaching the students how to handle the labor-saving machinery and acquainting them with the different kinds of tools and modern inventions, they are compelling them to take off their coats and swing the hammer, push the file and use the scraper. Unless they can do good hand jobs first, they are not considered proficient enough to go up to the higher work. This is needful for the complete education of the modern shop workers of all kinds. Employers are demanding that they shall understand the rudiments of their trade as well as the higher parts of it.

One of the most useful experiences for a young man in the shop is to be put to the repairing of intricate machinery. The problem must first be solved. This question must appeal to him: Is is possible to make the repair without taking the machinery apart and shipping the broken part to some distant shop for repair? Every hour that the machine is out of order a big bill is running up against the owner. It may be that the trouble develops in the busy season, and the machinery will lose hundreds of dollars a day to the owner. The man who can go down into the machinery and with a little ingenuity repair it—even if it is only temporarily until some new parts can be ordered—is worth more to his employer than his wages would amount to in a year.

It is not possible for a young journeyman or apprentice to do this without considerable experience and a training which makes him self-reliant and ingenious. If his shop practice has been limited to the simple work of manipulating machines and doing all kinds of work with labor-saving tools, he will not be of much use in an emergency. He lacks the skill and training which is the best background for a shop or theoretical education.

The high-priced men in all the trades are those who are called upon to do the unusual things, and who can be trusted to accomplish the results desired. The trades are full of young and old men who can do ordinary skilled work in an ordinary way; but there are few in our shops who can accomplish the unusual. In no department of work are there more unusual jobs turning up than in mechanics, machinery, and the repairing department of the large mills and factories. To meet these calls the worker must be something more than ordinary. The training for the work must be thorough, and from the ground up. Fortunate indeed is one if he is brought up in a shop where the foreman is one who appreciates the practical value of old-fashioned as well as modern training.

Recently it was found necessary by a prominent railroad to send a crew of workmen to repair a wrecked traveling car, which the company used for emergencies along the line of their travel. When the workmen reached the place of trouble, they found themselves a thousand miles away from any repair shop of the company. The wreck had been more disastrous than they supposed. The men did not have all the tools they were accustomed to work with. It looked for a time as if the traffic of the road would have to be held up indefinitely until the proper tools could be sent for. This would cost the road hundreds of dollars, and completely interrupt traffic along the whole system. The assistant foreman of the crew was an old-time shop-trained workman, and while the "new" men were giving up the job until they could get the necessary tools he started a temporary blacksmith shop and forge on the place, and within a few hours had shaped and prepared crude, but effective, tools to work with. In less than half a day the men were able to begin operations and the wreck was removed.

The workmen today are not permitted in shops to go beyond the draftsman's designs. These designs are supposed to be executed with all care, and they are absolutely correct, according to mathematical measurements and drawings, and the workmen are supposed to follow them implicitly. This habit has resulted a good deal in the training of workmen to depend entirely upon design and certain machine tools. They do nothing of their own initiative. They become slaves to a necessary condition that in time destroys original workmanship. The drawing is official, and supreme, and the workman who fails to follow it must be held responsible for errors. It is sometimes a question whether the workman should not study something more than the mere work of following and executing designs. Many a piece of work could be saved if the workmen understood something more than the dull routine of cutting according to line. It hurts no man to make a study of a design so that he has an intelligent appreciation of its meaning. The danger of interfering with its execution through a self-important knowledge, which leads some to assume they know it all, is offset by the fact that the most intelligent workmen always do better work, and accomplish more in the end in nearly every shop. When a man takes an interest in a piece of work he is sure to accomplish more than another who cuts according to line with no interest whatever in what he is doing.

There is a middle ground where the workmen in the shop and the draftsmen should meet. Without assuming to trench upon each other's field, they should have sufficient knowledge of each other's duties to be able to appreciate their difficulties and shortcomings. The draftsman's training is not complete until he knows something of the work that the men in the shop are called upon to do in executing his designs, for this knowledge will often enable him to save time and money for his employers. The drafting-room labor is necessarily high-priced, but its cost is more largely determined by the ability of the draftsman than anything else. A high-salaried draftsman is often the cheapest in the end. His work is not only surer and truer, but he knows how to design so that the least amount of labor and material will be required to execute the drawing when turned over to the workmen in the shop. This indirect saving may appear sometimes to employers as of a negligible quantity, but it is not so in large shops. It amounts to the cost of more than the salaries of several draftsmen in the long run.

No draftsman can do this sort of work satisfactorily unless he has a good working knowledge of the shop methods observed, and of the men and tools employed. He must know that his drawings are for the purpose of absolutely guiding the men, and that they must first be perfect in every line. There is no guess-work, or loopholes for errors. Positiveness of detail lines must be a part of his stock in trade. A familiarity with shop practice brings him in closer touch with his work, and he is enabled to design with more freedom, and with a surer knowledge that he will save money to his employers.

Now in the same way the workmen in the shop who knows something of the draftsman's art and skill will be able to appreciate better the requirements of his own trade. A healthy interest taken in his work will be stimulated. He will learn to appreciate a good piece of draftsmanship, and to recognize a poor and clumsily drawn one. In the latter he will naturally look for mistakes, and probably be on his guard so that in the end he may save costly mistakes to the firm.

It is not advocated that shop workers should take a course in draftsmanship—although this would not hurt them—but it is recommended that they should make a more thorough and complete study of the different lines of work touching upon their specialty. They require, first, a good training in all the different uses of tools, and then a knowledge how to manipulate the ordinary ones that are being discarded in many shops through the invention of machinery. They should know how to repair and keep in order the tools and machines intrusted to them. Second, they should take such a lively interest in their work that they cannot rest content until they know something about designing and the work of drafting as it is carried on in the best shops. This knowledge can be acquired with a little extra study and work in almost any shop, or at least from books or papers at home. Third, the ambitious workman in the shop should make it a study to improve his mind and invention by experiments with machinery and tools. Place a few problems before the mind, and work them out on paper. What would one do if this or that part of an intricate machine should break or get out of order? If a steam engine or electrical dynamo should suddenly stop running without any apparent cause where would one look for the trouble? It is possible for one to put such questions before the mind for solution so that in time he would be prepared for many emergencies in the shop or mill.

The modern tendency to specialism hurts the individual if he is content to master simply the details of his own chosen line. If he cannot carry his enthusiasm and interest in his work beyond his own immediate field of operation he cannot prove the valuable man of the shop which every foreman and employer are constantly on the lookout for. He must prove his worth by his studies and efforts. Some workmen wtihout any theoretical knowledge of other fields of work will show such interest in their endeavors that they will pick up in the shop by actual experience a complete working knowledge of other specialties that bear directly or indirectly upon theirs. They find that this extended experience always helps. It helps them to do their work more intelligently, and some day there comes an opportunity to prove their value as a man of ideas and reliance.

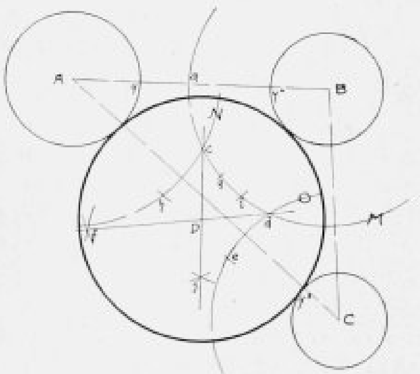
It should be assumed that every workman in a shop is ambitious to better his condition, and to make his services of more worth to himself and his employer. This is particularly true of the young workman. He can accomplish this only along the lines suggested. He must make his work perfect, so far as human skill can do it, and then show a mind broad enough to grasp something more than the details of his daily routine jobs. He may wait years before this acquired skill comes into use, but if he waits half a life time the pleasure derived from knowing is worth all the effort. American shop workers are the most intelligent in the world; but there is still room for advancement. Otherwise the American youth would be robbed of the natural incentive to do better work than his companions, which is the zest and life of existence.

To Describe a Circle Tancent to three given Circles.

H. MACDONALD.

I SEND you this geometrical construction; it is one which I came across in gearing.

I have never seen it in any geometry or book of geometrical construc-



tions, and it is original with me, for I worked many hours to get it.

I have given it to many engineers, draftsmen and students, none of whom could work it out.

PROBLEM.—To describe a circle tangent to three given circles whose diameters are different.

SOLUTION.—Let *A*, *B* and *C* be the centers of the three given circles, whose diameters are different. With *B* as a center and a radius of about one half the distance *AB*, strike the arc *M*. With *A* as a center and a radius of *Ay* plus the distance ay', strike the arc *N*, cutting arc *M* at *c*.

With C as a center and a radius of Cy^2 plus the distance ay^2, strike the arc *O*, cutting arc *M* at *d*.

Bisect angle *edg* to get point *f* and draw line *fd*.

Bisect angle *hci* to get point *j* and draw line *cj*.

The intersection of lines *fd* and *cj* is point *D*, which is the center of the required circle.

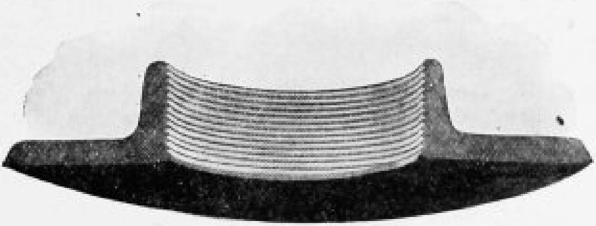
Forged Steel Flanges.

LIKE everything else a boiler is apt to be judged by the first impression its appearance creates.

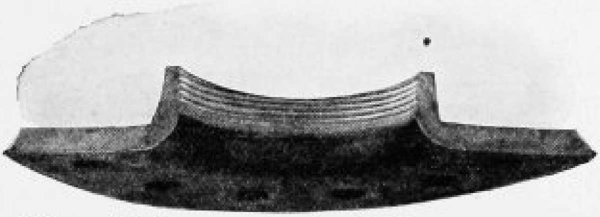
A boiler or tank with neatly calked seams, well set rivets and sightly flanges finds ready favor with the customer, where the slighting of these details in a boiler or tank equally good or strong might lead to its rejection.

Purchasers of boilers will testify that altogether too large a percentage of cast flanges crack during shipment or setting of boilers, and any experienced boilermaker will also say that on an average one cast flange in ten crack when the last rivet is put in, in securing it to the boiler.

A reinforcement of the hole must



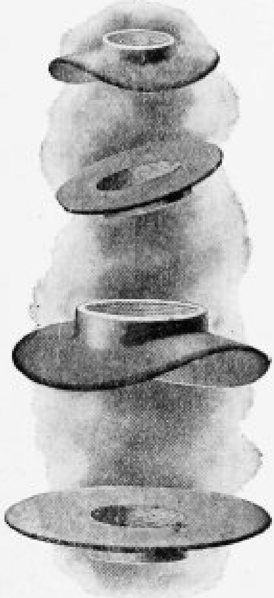
be made so that in the case of a pipe the threads may be of a number to insure a tight joint, so a piece of boiler plate is often shaped and riveted on.



"Pressed" flanges made from boiler plate are weakest where the strain is greatest—at the foot of the hub, because in pressing the flanges the metal is drawn thinnest at the right angle turn. Worse still in the pressed flange it is possible to cut only three

or four full threads, owing to the widening of the inside diameter due to the sweep or curve that is an unavoidable defect of every pressed flange and which leaves a "hatching place" for rust and scale.

With the improved type of flanges, the Ryerson Forged Steel Flanges—a full deep thread running flush with



bottom is obtained, due to the extra high neck.

A square sharp corner at the base of the thread is also secured and the danger of corrosion of flange and shell that takes place under the dead portion of a pressed steel plate flange is avoided.

The Ryerson Flange is made of homogeneous soft steel of 60,000 lbs. tensile strength, tough enough to withstand the greatest strain, but sufficiently elastic to conform to any slight inequality of the shell.

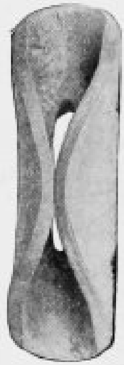
A comparison of the forged and cast flanges is made in the following table.

—TABLE—

Size Pipe Inches	Diameter Inches	Thickness Inches	Equivalent To Cast Iron Inches
¾ inch	6 inch	5/16 inch	1½ inch
1	6	5/16	1½
1¼	6½	5/16	1½
1½	7	3/8	1½
2	8	3/8	2
2½	8½	3/8	2
3	9	3/8	2
3½	9½	7/16	2
4	10	7/16	2
4½	10½	1/2	2
5	11½	1/2	2
6	12½	1/2	2
7	14	5/8	2
8	15	5/8	2¼
9	16	3/4	2¼
10	17½	3/4	2¼
12	20	13/16	2¼

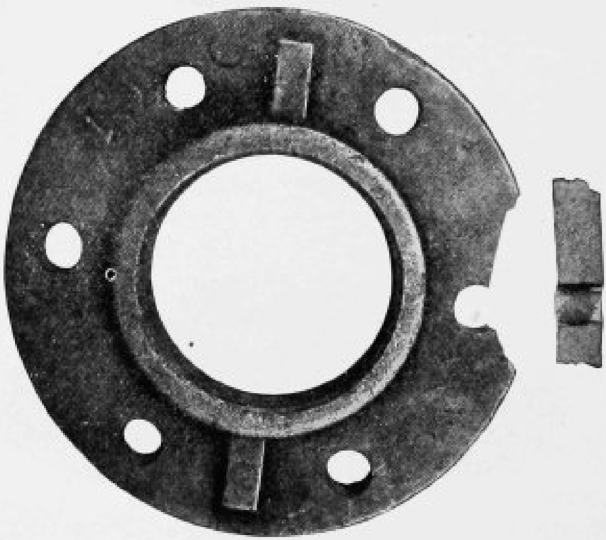
Forged steel flanges may be secured either flat or bent to any sweep or shell from 18 to 72 inches, and special flanges can be made to suit requirements.

Much of the same attention will have to be given to rivet spacing for



a forged flange as for a steel plate of the same thickness.

The edges are lathe finished and beveled for calking and a tight fit easily secured.



Cast iron flanges crack easily while Forged flanges can be mashed into any shape without breaking.

NOTE—We are indebted to Josph P. Ryerson & Son, Milwaukee Ave., Chicago, Ill. for Illustrations and table.

The Correspondent Student as an Inventor.

IN all technical schools that carry on instruction by correspondence the faculty have discovered that many of the students, after they have attained an educated knowledge of their work, are very successful along the line of invention. At first thought it might seem somewhat strange that a man who, for fifteen or twenty years, has been no more than a fireman or a machinist, should suddenly branch out as an inventor. A thoughtful consideration of the conditions, however, will quickly change that view. The man has had fifteen years of practical experience in the machine shop. He knows by actual handling, day after day, the weak point in a certain machine. He cannot help thinking about it, because he is brought face to face with the machine every working day; but knowing nothing of the scientific principle upon which the machine is based, he is unable to reason out an improvement. Suppose the man takes up the study of mechanical engineering by correspondence. His background of practical experience is of inestimable value in his studies. As he goes on, he begins to see the cause of the weak point in the piece of machinery, and naturally he starts to work to overcome it. One thing leads to another, and the probabilities are that he invents some useful improvement that increases the working capacity of the machine.

In the experience of the students of the American School of Correspondence this has occurred over and over again. One pertinent example of the foregoing is the recent invention of an automatic stoker by George F. Tinkham. Tinkham was born in Middleboro, Mass., and when a boy of eleven left school and started work (his father was serving in the Civil War). At twenty he enlisted in the United States army and saw active service in several Indian campaigns in the Northwest. From then on to 1887 he worked as a fireman and assistant engineer in different plants in Iowa. The result of his experience as a fireman was the developing of an idea for increasing the capacity of boilers and consuming smoke,—an idea which, during his correspondence course, took practical form in a patent automatic smoker.

The plant in Cleveland, Ohio, of which Mr. Tinkham is now engineer, has two boilers equipped with his device. It is seldom that there is even a trace of smoke issuing from the chimneys. Moreover, careful tests have shown that his device largely increases the capacity of the plant, as the boilers, which are rated at only 146 H. P., develop by actual test 241 H. P., an increase of about 45 per cent.

Mr. Tinkham had few opportunities for obtaining an education. He ceased attending school at the age of eleven, and for thirty-seven years found little time for study. In September, 1900, he began a stationary engineering course in the American School of Correspondence. The knowledge derived from his studies has been of great practical value to him in his work. His chief regret is that he could not have had this opportunity earlier in life.

Formulae for Position of Center of Gravity of Trapezoids.

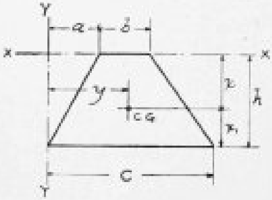


FIG. 1

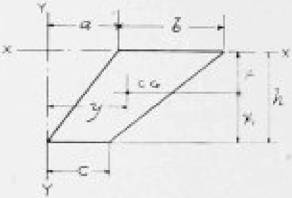


FIG. 2

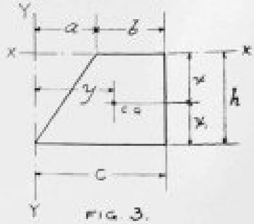


FIG. 3.

$$x = \frac{h(b+2c)}{3(b+c)}$$

$$x_1 = \frac{h(2b+c)}{3(b+c)}$$

$$y = \frac{ac+2ab-bc}{3(b+c)} + \frac{b+c}{3}$$

also – $$y = \frac{ab+b^2}{3(b+c)} + \frac{a+c}{3}$$

For Fig 3 only – $$y = \frac{2c}{3} - \frac{b^2}{3(b+c)}$$

Mr. F. W. Seidensticker, of Chicago, sends the above formulæ for finding the position of center of gravity for trapezoids, which may be useful to our readers.

Ideas of an Inventor.

No more striking way of handling a fortune has been discovered than Mr. Gordon McKay's bequest of $4,000,000 to Harvard collge for science, while his sons receive $100 a year, with perhaps a little more in the future. He has thrown into relief the importance of scientific study in our day, and he has put into active practice ideas which are ostensibly held by Mr. Andrew Carnegie and other critics of wealth. In judging such bequests the general world must leave out any personal details which might contribute to the result, as it knows nothing of the family relations or the natures of the boys. The interesting question is on the principle involved. We are inclined to think that Mr. McKay's act, if it represents a principle, will seem extreme to the majority of liberal minded Americans. To have left $3,000,000 to Harvard and divided $1,000,000 among his sons would have been liberal to science, and would have given the boys a better chance in the world, if they are made of good material wisely directed. If a youth is not able to use a favorable pecuniary start to advantage, there must be something wrong in his nature, or, what is more likely, in his bringing up. The worship of the self-made man, which was rife a generation ago, has disappeared, and the principles which make it well for a boy to have money spent upon his education also make it well for him to have the advantage of some money in beginning independent life, provided he is strong enough to use it to enlarge his opportunities instead of diminishing his responsibilities. Nevertheless, although that truth can hardly be denied, the general influence of a will like Mr. McKay's is good, in as far as it raises the banner of public spirit and intellectual ardor against the too rampant spirit of private wealth.—Collier's Weekly.

Candle-Power of Incandescent Lamps.

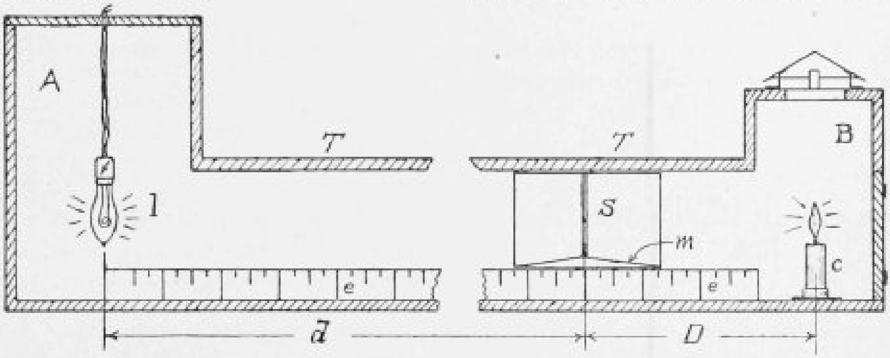
By H. B. White.

IT MAY be interesting to the readers of this magazine to learn just how the candle-power of incandescent electric lamps is determined.

In the first place I will state that the candle power is the number of standard candles that would produce a light of equal brilliancy. A ⅞ in. spermaceti candle is considered the standard unit in general use.

The illumination of a candle at a distance of 1 ft is called a candle ft. and is considered a good light to read by.

Moonlight is equal to .025 candle ft. An instrument called a photometer is used to measure the candle-power of incandescent lamps.



There are several forms of these instruments, but they all involve the same general principle.

We will consider the one known as "Bunsen's photometer" shown in our sketch.

(A-B) represents a box having the inside walls coated with a non-reflecting paint and made in two sections as shown. (L) is the lamp to be tested, while the candle is shown at (c). The horizontal tubes (T T) project from the sides of each section of the box and are provided with a scale (e) by which means the position of the screen (s) is determined.

The screen is a small sliding frame in which is inclosed a piece of paper.

There is a spot on this paper (usually a grease spot) that is more translucent than the surrounding part. On each side of the paper is placed a small mirror (m), so inclined that the spot on the paper is visible from above through a horizontal slit in the tubes. In making the test the room is darkened and the screen is adjusted along the tube until the spot on the screen disappears. This shows that the candle light and the electric light have the same effect on the screen. If the screen was half way between the candle and the electric light they would be identical, i. e. I. C. P. but the adjustment would be quite different with a 16 C P lamp.

The following rule is the base of all calculation. The intensity of light received by an object varies inversely as the square of its distance from the source.

Thus—If a light of 16 C. P. intensity is 4 ft. from an object and is changed to a distance of 8 ft. the intensity will be ¼ of 16 or 4 C. P.

Here is the formulas.

Let l=lamp to be tested.

Let d=distance from lamp tested to screen.

Let D=distance from candle to screen.

The C. P. of lamp then is $l = \frac{d^2}{D^2}$

Example: If a photometer screen shows a distance of 20″ from lamp to screen and 2″ from candle to screen what is the C. P.?

d=20″

D= 2″ then

$$l = \frac{20 \times 20}{2 \times 2} = \frac{400}{4} = 100 \text{ C. P. (ans.)}$$

or say d = 16 and D = 4 then,

$$l = \frac{16 \times 16}{4 \times 4} = \frac{256}{61} = 16 \text{ C. P. (ans.)}$$

The photometer here considered is the one mostly used in the manufacture of incandescent lamps. After the filiament is placed in lamp it is desired to know the voltage that will be proper to use for its economical operation.

It is determined by placing a lamp of known C. P. in the photometer in place of the candle. This lamp is supplied with the exact voltage to bring it to the required C. P.

The screen is placed midway between the sample lamp and the lamp tested.

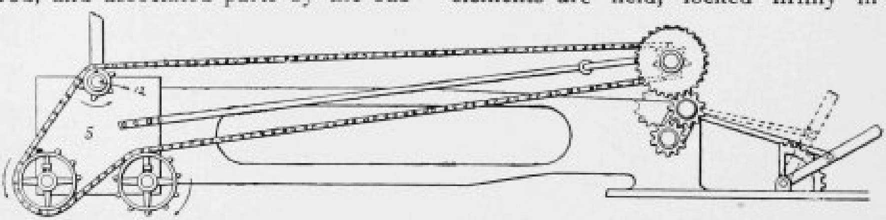
The latter is connected in series with the source of power and a rheostat while a voltmeter is in shunt circuit.

The rheostat is then adjusted to bring the light to such luminous intensity that the paper diaphragm of the screen shows equal brilliancy on entire surface.

The reading of the voltmeter will then show the proper voltage required for the lamp.

A Novel Valve Mechanism.

THE accompanying illustrations from The Practical Engineer show a very unique valve reversing mechanism for steam engines. The strongest point of the arrangement is the doing away with the usual eccentric rod, and associated parts by the substitution of rotary devices and transmitting gearing adapted to drive the valves so as to admit the steam equally to opposite ends of the cylinder alternately; and to exhaust in like manner therefrom. Thus any possibility of an unbalanced stroke is overcome and the use of cylinder cocks entirely obviated.



A further object is to provide a simple reversing mechanism, in which the elements are held, locked firmly in their adjusted position, so that the lead can be reversed by a simple movement of the lever.

The same numerals of reference denote like and corresponding parts in each of the several figures of drawing —5 designates the cylinder, 5 the feed chamber, to which the steam is supplied by pipe, 8 is the inlet parts, 10 is

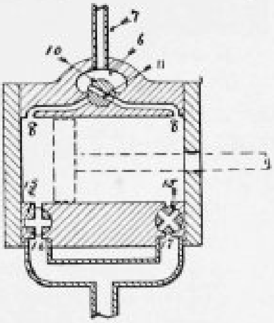


Fig. 2.

a revolvable inlet valve, having a single transverse passage, 11, 12 valve spindle, 15 stuffing box, 14 is a lead on feed chamber 6, which can be removed for purpose of taking out the valves, 15, 15, are exhaust parts, 16, 17, are exhaust valves with intersecting passages see (figure 2).

It will be seen that the valve 10 travels at half rate of the engine and valve 15, 15, at quarter rate of the engine.

It can also be made as an expansion cut-off by the size of inlet part II.

The wear on the valves will be greatly reduced by their having such slow motion, and by the way in which they are placed the back pressure will also be greatly reduced. The reverse is also so simple that it will be understood without explanation.

To Lay Out Arcs and Lines.

To Lay out a line equal to a given arc, draw the chord A—B, Fig 1. and extend it and make B—C =1-2 A—B.

With C as a center and a radius of C—A strike line at E, then E—B is approximately equal to arc A—B.

To lay out an arc equal to a straight line, devide A—B Fig. 2. into four parts and with C as a center (CB=1-2 AB) and radius C—A strike arc at D, then B—D is approximately equal to AB.

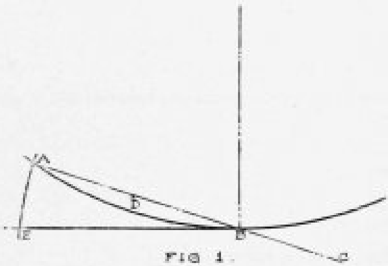


FIG 1.

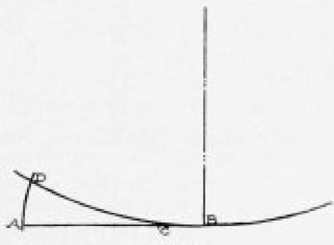


FIG. 2

Architectural.

The Use of the Mirror for Illuminating Dark Cornres.

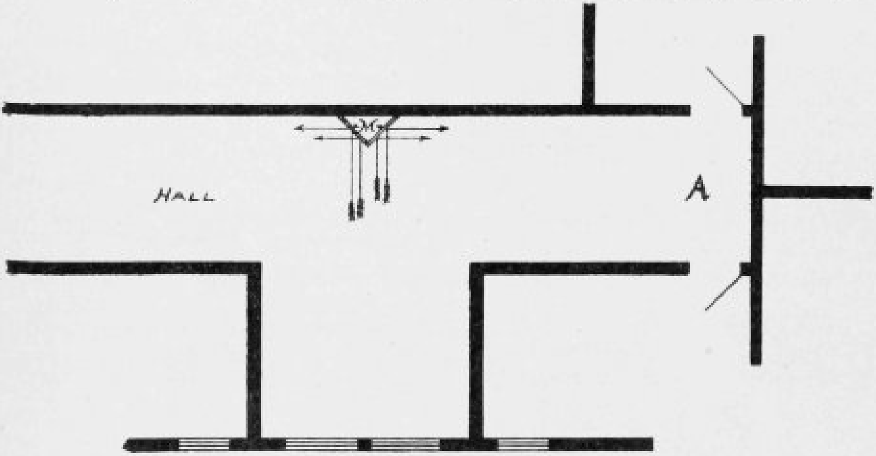
THERE are in architectural design many things that tend to worry the draftsman, and the builder, too, and one is to avoid dark corners.

To arrange all the rooms to receive outside light is quite a task and the entrance to these rooms must be made somewhere, to be sure, but not to take too much light of the rooms.

A certain apartment house has two suites of rooms entered from a center hall, but the arrangement made a dark place at the doors. Some distance down the hall was an alcove with two nice large windows on the wall opposite those windows were placed two mirrors, back to back, set at an angle, each being 45° with the wall.

It is a principle of optics that a ray of light is reflected at the same angle from the surface of a flat reflector as the angle at which it comes on, that is, the angle of *incident* is equal to the angle of *reflection.*

The light coming in at right angles to the wall is at an angle of 45° with



the glass, and since it passes off at the same angle, it would be then parallel with the wall and be cast into the dark corner at *A*.

On a clear bright day, the part at *A* is well illuminated and that to the left would be much helped, too.

Mirrors 24 inches wide and 3 feet long will give fine results in a hall of 6 feet in width and 20 feet from mirror to dark spot.

Building Construction.

Continued from page 296 the December Issue.

THESE articles on forces applied to structures go a very short way, but they go far enough for the *needs* of a practical man, who, if he is curious in this direction and has a taste for mathematics, may go as much further as he likes. In my endeavor to be practical I have written from my own experience of the kind of calculations which arise in ordinary office work. The subject is a department of mechanics. I have tried to pick out, without any show of want of sequence or incompleteness, the questions which arise in building construction. The student may reasonably assume that if he studies these articles and understands them he will be prepared to deal quantitatively with any strength question, moderately determinate, likely to arise in building practice. It is surely of advantage to have the essential things selected and put in concise order. We know that the pendulum of a clock does not fulfil all the conditions of a "simple pendulum," but it keeps time with efficient accuracy for practical purposes. We know that no two separate pounds of sugar weighed out to customers by a grocer are of exactly the same weight, and that no two separately cut yards of cloth sold by a draper are of the same length, but the weights and lengths are practically correct. It is not sought to be conveyed that any carelessness of estimate or measurement is pardonable; this is not so. The test of accuracy in a clock's pendulum is that the clock will keep time; of the grocer's and draper's accuracy, that their customers reweigh and remeasure and are satisfied, and that the quantities sold agree in their totals with the quantities which the grocer and draper bought wholesale. A constructor must design safely and economically.

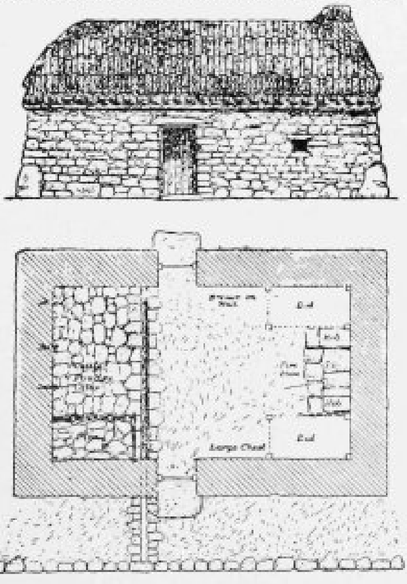


Fig. 76.

The few principles which have been illustrated and dealt with are of very frequent application in very different ways, but the student must not for a moment think that they are restricted to the cases given. For example, some of the considerations in connection with beams fixed at one end apply to a pillar to which a heavy gate is hung, or to a wall or chimney in a wind. The question of distribution of pressure between surfaces which has been considered in reference to arch voussoirs, and again the same principle in connection with the consideration of the center of pressure at cross-sections of struts, is one of very wide application. But it is not necessary to multiply instances.

These few words must not be taken as any "farewell address" to force calculations. On the contrary, the student has been introduced to principles which it is to be hoped will remain in his mind for everyday application and extension. It is to be feared that building students have not hitherto had their attention sufficiently directed to this *funndamental* part of their work.

HOUSE BUILDING.

54. There is no human construction that does not exhibit care and carelessness, wisdom and lack of wisdom; and it is the business of the student to see both sides and to profit by what he sees. The simplest kind of house or shelter is probably the piece of bark with which the Tierra del Fuegan shields himself from the cold wind as he moves about. The Australian blackfellow sets up three pieces of bark to shelter his head and shoulders when he sleeps. We are aware that we skip a large number of terms in our advancing series when we take a Connemara cabin (Fig. 76) as our starting point for the study of house building. We are further discriminating, because our Connemara cabin is a specially good erample and we shall find admirable construction points in it. The builder of this cabin has as good grounds for pride in his work as the builder of many more pretentious houses. In judging a man's work we must take account of all the circumstances. This single-roomed house to shelter the Connemara peasant and his live-stock is what he can afford, and it must be made of such materials as he has at hand. In some places he cannot get lime within miles of his house, and so he must build with very little lime. The walls are dry-built of granite (in the house shown) and the inside is pointed and rough-plastered with mortar; when it can be afforded the outside is also pointed, and when this is done the house is fairly warm and comfortable—warmer than a solidly mortar-built house because the air enclosed in the dry walls is a non-conductor. The house has two doors, as some people think (and, indeed, as the people who live in the house will tell you), so as to use either side for entrance when it happens to be the lee side. There is something in this, because if you observe the window you will see that an open door is needed to give light; but the two opposing doors have another function—the peasant's small growing of oats is winnowed on the floor in the current of wind between the two doors. We, pampered people, know that a door opening directly from the outside is a draughty arrangement, and we protect ourselves with a porch and second door. It is still more draughty to have these two badly-fitting doors opposite to one another, and to mitigate the draught the closed-up door is lined inside with a plaited-straw mat (*sugan,* a paillasse), which is held up close to the door and the side chinks with raking props. The enclosure for the pig must be very strongly paved and secured, because these animals can perform wonders of destruction with their snouts. The fastenings for the cattle are hooked branches of bushes built into the wall. The bed mattresses are *sugans.* Other sitting accommodation is provided by stools (not shown). The principal table is the lid of the chest; the dinner is potatoes, and the dinner table is a flat basket placed on a bucket or stool. The roof is peculiar; the thatch is not of straw, and it is not secured with scollops. There is not much straw available, and scollops are not to be had; hazel bushes do not grow within twenty miles of this house. Note the network of roping and the row of stones along the eave. The foundation for thatch is prepared in the usual way, that is, a few collar-braced rafters (couples), pegged together with wooden pegs, are set up, then some rough branches are laid across them, and over these small branches are laid, lying up and down the slope of the roof. On these are laid "scraws," which are sods of a suitable kind skinned off the land very carefully and carried to the house in large rolls—one of these scraws may be two feet wide and ten feet long. The thatch is coarse sedgy grass, laid on carefully up and down the slope of the roof in sufficient quantity to give

the proper contour, without any fastening; it is held in its place by the network shown. In many of the cabins the work is badly done; ordinary straw-thatching is apparently imitated and the side of the roof is given a plane surface. Now it is easy to see that if there is not a rounded surface the network cannot give support or pressure to the grass thatch, and flat thatching is therefore bad and unscientific. The cords are mostly twisted, made from the same grass which is used for thatch; but cocoa-nut-fiber string is not uncommon—it stands the weather well and it is lasting. A rounded waggon-shaped roof is successful in this case, for much the same reason that it is successful as a felted roof. If you cover a flat piece of boarding with felt, any wind that gets inside (through a door or other opening) lifts the felt off the

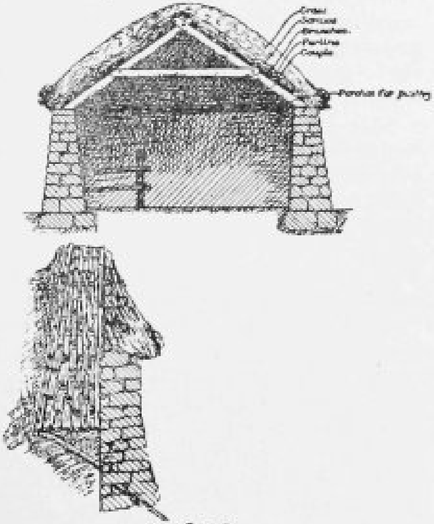


FIG. 78

boards, the nail heads pull through and the felt is carried off. With a waggon-roof it does not lift off; any attempt to lift at any part tightens it against the boards at every other part, and the friction against the boards helps the nails to keep the felt in place. The drawing shows the strings held down by stones along the eaves; they are quite as frequently fastened to pegs driven into the walls below the eaves. The drawing also shows the thatch covering the ends (the roof hipped) of the house, the gables. This is not the most common way, but it is the best way. With ordinary thatch a gabled house has the barges made to the thatch with mortar, and some care is taken with mortar flashings to the chimney stacks. This cannot well be done with loose grass thatch, and, as commonly done, the barges are a very unsatisfactory job; the method shown is quite good. This is the necessary kind of roof where the walls of the house are of dried mud (whether thatched with straw or grass), and with mud walls the eaves must be more projecting than as shown. If we take full account of all his surroundings, the builder of one of these humble dwellings may be a brother member of our craft who is fit to hold up his head among us.

55. Let us watch a man thatching with wheaten straw. He is putting on a "new coat" of thatch; he has moved his ladder, which lies evenly on the old thatch, and now marks the extent of the strip he is about to lay. The edge of the work he has before completed is kept from spreading by a number of straight scollops (hazel rods) stuck at right angles to the roof close to the edge of the new straw; he takes a handful of wheaten straw, regulates the butt ends with the palm of his right hand while he lays it in its place, then another and another, till he has as much as a scollop will properly span; he bends his scollop into a flat staple and thrusts it into the old thatch, enclosing the new. A second scollop brings him to the side of the ladder, then he takes a third and a fourth scollop, bends them sharp in the middle and pushes them in so as to hold fast the centers of the first pair; he lightly settles the scollops with his mallet, and repeats the operation till he reaches the ridge, where, if he is an artist, he finishes in lopped and twisted handfuls of straw which

are made fast by scollops in the loops in a way to remind one of the dowelling of roll ridge-tilling. The operation is exceedingly simple. Why does not the small farmer or peasant do his own thatching? Why also does he not make his own baskets and heather brooms or besoms? How many of us know the difference between a granny's knot and a reefing knot? Can anybody but a shopman make up a neat paper parcel? If we are to control workmen we must have their respect; if we are to have their respect we must understand their work. We must not only know bad work; we must know why it is bad work. We can only come to this knowledge by effort, and by becoming familiar with workmen, watching them intelligently at work and occasionally taking a hand ourselves.

56. Fig. 77 shows a Syrian house built of stone, such as may be seen in the neighborhood of Beyrouth. Because timber is expensive the walls are thick, and the roof is formed by vaulting. The face work is ashlar in alternating bands of light-colored and dark-colored stone. The roof is flat, and has a parapet. There is an outside stone stairs, and there are two shelters formed of cane mats on the roof (except in the rainy season the roof is the sleeping place). The opening through between the rooms is really the living room, and is designed for draught and coolness; the cane mats shown enclose the place and give privacy to the family. The windows are barred openings which may be closed up by the shutters shown. The way in which the centering for the vaulting is formed is as follows: Some pieces of timber are put up on sufficient supports, either timber or temporary dry walling—hewn pine pieces, kept to be let on hire for this purpose and charged for if cut or damaged in any way—the spaces between the planks are spanned with spauls of stone, and this is covered with mud which is worked to the shape of the vault. When the mud has dried so as to be fairly stiff it is covered with sand which is pressed firmly, and on this the sheeting is worked. It was a common plan in our own country to use wicker hurdles as lagging for vaulting. This house has a low parapet, four gargoyles are shown, and it has the usual flat roof of a Syrian house. There is no chimney. Cooking is done over small charcoal fires kept bright by the use of a feather fan, and only alight when they are required for cooking. Why are these roofs flat? What is the use of the small stone roller to be seen on every housetop (shown in Fig. 78)? The reason for the roofs being flat is very simple and natural: the roof is of clay or of a mixture of clay and lime, and it must be flat to prevent strong currents of rainwater washing it into channels and destroying it. The roller is for rolling the roof to close up cracks and generally consolidate and make the roof good during the "welcoming month" before the rainy season sets in.

57. Fig. 78 shows a house of the same character and giving the same accommodation as Fig. 77, but it is built of unburnt sundried mud blocks instead of stone. Houses of this kind are to be seen at Zahleh in Lebanon, where the eastern slope of Gebel Sunnin approaches the plain of the Bukaa. A brawling stream from the mountains runs through the little town, and on its banks some poplars grow; these poplars appear to furnish the poles to carry the clay roof. There are many other places where the houses are of mud (Damascus is a mud-built city). The poles are cleared of their bark, and when one gets inside the building he finds that peeled small branches have been laid to form simple patterns lying on the poles, showing appropriate ceilings having a good decorative effect. The doors of these houses have wood hinges; they are fastened with wooden locks which are opened with wooden keys. The projecting eaves protect the mud walls from being

rainy season.

Fig. 79 shows one of these locks wtih its key. The "Encyclopædia Britannica" says: "The earliest lock of which the construction is known is the Egyptian, which was used four thousand years ago." This is the common lock used on the doors of these Syrian houses.

58. Have such elementary buildings any architectural value? The Eastern houses between which and the Connemara cabin some comparison is suggested are not nearly the poorest kind of dwelling to be seen in Syria. There is evident intentional efforts at decoration, and they also have a satisfactory

Fig. 78

Fig. 77

effect when seen from a distance. A village of these houses built on rising ground, placed as the houses of Eastern villages are, without any regard to regularity in respect of road or street and mixed with the green of a few mulberry bushes or similar things, is a very pleasant sight. The builder of such houses has very little room for the display of originality; he works to a cut-and-dry design, a type as permanent as the dress which poverty makes unchanging in countries where people can barely live. Yet in such houses there is room for the display of taste and skill.

I must not be understood as saying that habitations like the Connemara cabin are satisfactory for human beings to live in. We have a Public Health Act, and we have sanitary officers and inspectors, and we have laws by which the district council may build suitable houses for laborers; but these remedies do not touch, in any practical way, the evil. Where the ratepayers of a district are all equally poor, they cannot collectively help each of them to a new house with reasonable accommodation for animals and separation of the sexes. Our political conscience has reached a point at which it is allowed that civilization may say, without suspicion of socialism, "We will not allow the owner of a soul to die of hunger."

(To be Continued.)

Concrete Pipe Foundations.

THE exigencies of foundation work in soft ground are often met by concrete piers, sheet piling and other means; but lately the use of concrete piles has replaced much of the older methods. The concrete pile foundation is largely used in New York, where tall buildings on the soft substratum have to be carried, and where deep excavations and often pneumatic caissons have to be employed. The concrete piles may be driven without excavating and the cost of piers avoided. As no excavation is necessary there is no danger in undermining adjoining buildings or of pumping, and the work can be done much more expeditiously. Concrete piles are also permanent, whereas wooden ones have to be kept saturated. The concrete steel pile is quite free from these drawbacks, and can be used in the wettest as well as in dry soils. The Engineering Record lately gave some particulars of the concrete pile foundation for the Hallenbeck building addition at Park and Pearl streets, New York, a ten-story steel frame structure. The wall columns of the older part, carried on I-beam grillages imbedded in the concrete caps of clusters of wooden piles, was found, owing to the lowering of the ground-water level, due to the drainage caused by the rapid transit subway near, to be too costly. The wooden piles would involve trenching several feet below the bottom of footings, and underpinning would be necesary to carry the foundations down. The concrete pile plan was found to be less costly, so was adopted. The contract specified a substructure composed entirely of reinforced concrete piles, extending to a height of about six feet above the ground-water level, where they are then made integral with the concrete grillages and concrete floor slabs. Sections are given in the Record of the concrete-steel piles and girder seats. The foundations consist of clusters of piles in two longitudinal rows, which carry transverse cantilever I-beam girders. These support the wall columns beyond the centers of the piles. The Record describes the piles. The piles are twenty-eight feet long, twelve inches square, made with 1:2:4 Portland cement concrete, with one-half inch crushed trap rock rammed longitudinally in wooden moulds. The piles are calculated to support 80,000 pounds each, including a load of 36,000 pounds per square foot on the concrete, as allowed by the New York building laws for concrete piers, and are capable of receiving an additional load of 44,000 pounds, which is assumed will be supported by the four soft steel vertical reinforcement rods, which are bedded in the concrete, and are allowed to work in compression up to a load of 7,000 pounds per square inch. These rods are tied together on all sides by horizontal hooked wires five inches apart, and at the bottom they are bent to the angle of pryamidal pile point, and are seated on a solid cast-iron driving point locked to the pile by wrought strips bent 90 degrees at the top. The whole of the reinforcing rods of the hooked wires are embedded in the concrete, which forms on plan a square 12 inches. The four reinforcement rods are placed at the four corners of the pile surrounded by concrete. Each rod is one and seven-sixteenths inches in diameter. The section shows how the rods converge at the bottom and rest on the solid cast-iron driving point above mentioned. The cast-iron point is pierced by a one-inch jet hole through its center, and the jet pipe is brought outside the pile. The bottom pyramidal part of pile is also strengthened by wrought-iron strap. The concrete extends two inches above the tops of rods, so as to form a seat for the driving cap. Mr. H. C. Pittman is the architect and Mr. F. A. Burdette, C. E., the consulting engineer for the steel construction, designed the substructure. The vertical rods are intended to be made to connect directly with the grillage, which is also reinforced.

It has been estimated by an expert in the employ of the government that agricultural machinery reduces the number of men employed to do a given amount to one-third, while manufacturing machinery reduces the number to one-fiftieth.

Nearly 30,000 patents were issued at Washington last year. We are an ingenious people and invent a great many things that cannot be used.

The English statute mile was first defined in the thirty-fifth year of Queen Elizabeth. Before that time it was put down at 5,000 feet.

The Chicago Alumni of the Engineering Department of the University of Michigan have ordered a portrait of the late dean of the department, Prof. Charles E. Green, from the well-known artist, Mr. Ives, of Detroit. The portrait is to be placed in the new engineering building as a memorial to Prof. Green.

Paris has no less than 1,216 classes of workmen. There are, for instance, 386 classes engaged in the chemical trade and 370 in metal industries.

The Botallic mine in Cornwall runs for two-thirds of a mile out under the sea.

HOME STUDY.

Elementary Mechanics.

The First of a Series of Articles on the above Subject.

BY N. C. HURST.

MECHANICS is the science of rest motion and force. It treats of the laws of equilibrium and motion and is subdivided into *Statics* or forces at rest and *Dynamics* or the effects of forces when motion is produced on bodies in motion. Thus *Statics* apply to structures such as roof trusses, bridges, etc., or any structure or body that is practically fixed or rigid while *Dynamics* applies to force in motion or transmission machinery such as gear trains, shafting while transmitting power and all machinery used to convert potential energy into motion or active work. *Elementary Mechanics* then, from the definition of the work elementary, treats of the fundamentals or first and simplest derived relations of rest, motion and force. Before taking up and discussing the various relations of these quantities and applying them to even the simplest of mechanisms we must first get a clear idea of their meanings as they are used in the mechanical world.

Rest and *Motion* of a point or body (a point being considered a body of very small dimensions or size) is always relative to some other point considered as a fixed point or point of reference—a fixed point in applied mechanics being a point at rest with respect to the earth or to the structure as a whole. Now suppose we take two points and join them with a straight line. If this line does not change in length nor position the points are said to be at rest with respect to each other and to each other only. If the line changes direction one point must be revolving about the other or if the line changes length the points are moving from or toward each other or the line may change both in length and direction. Upon a little reflection we see that there may be more than two points to consider and that these points may, while at rest with respect to each other, be in motion relative to some other point. As an illustration consider two or more mountain peaks on the earth's surface. With respect to each other they are at rest, but with respect to the sun are in motion since the earth revolves about its axis and it in turn about the sun. Thus we see that *Rest* and *Motion* are essentially relative.

Force is an action between two bodies causing or tending to cause changes in their relative positions or motion. Our only idea of force is obtained through muscular sensation or observing the work of some machine, such as a hydraulic forging press or the moving of a heavy object.

With a clear idea of rest, motion and force we will now discuss some of their combinations or derived quantities and condition that must be fulfilled.

Work is the product of a force by the distance which is passed through in the direction of the force by the point of application. It is expressed as *foot pounds,* being the product of the force in pounds and the distance moved in feet.

Moment is the product of a force by the shortest distance of its line of action from a fixed point or fulcrum. It is expressed as *pound feet* or *pound inches* to distinguish its from *work* which is of the same dimensions. Some authorities express *moment* by the word *poundals,* thus avoiding possible confusion with *work.*

Power is the rate of work or the doing of a certain number of foot pounds of work in a given time. Thus when 33,000 foot pounds of work are done in one minute the power exerted is called one *horse power.*

Equilibrium is that state which exists when all forces acting upon a body, mechanism, or point balance each other and the body, mechanism, or point is at rest or moving at a uniform rate of speed. It exists when action is equal to reaction or when the impelling force is equal to the resisting force or when the work delivered by a machine is accounted for in output or work done. If this condition is not fulfilled it means that the body or mechanism is either gaining or losing velocity and will continue to do so until a state of balance or equilibrium is reached. Equilibrium in a business sense means a balance of accounts, i. e., that the difference between the debit and credit columns must be equal to zero. The mathematic expression used to represent this condition represented thus (Σ m=O). (M) we will say represents moments about the particular point in question and (Σ) means "the algebraic sum of all such terms as" or the algebraic sum of all the moments, forces, work, or whatever we may be dealing with. This expression Σm=O) is the *vital equation* in all investigation in mechanics and a thorough understanding of it must be had before the moments, forces, etc., acting on a body can be intelligently dealt with. As a simple example let us investigate the action and reaction between a table and a five-pound block or iron placed upon it. Let the weight of the block be represented by (W) and let us assume that the table is strong enough to support the block or in other words the block and table are at rest, or in equilibrium. Let the reaction of the table be (W'). Now since action is equal to reaction (W'=W). Transferring (W) to the left side of the equation, remembering that the sign of (W) must be changed in doing this, we have (W'—W=O,) or the algebraic sum, which fulfills the condition (Σ W=O). Here the upward force is taken as (+) or force positive and the downward force as (—) or negative.

With a thorough understanding of the meanings of rest, motion, force and their derived quantities and the conditions that must be fulfilled, let us now apply them and analyze some of the simpler mechanical appliances beginning with the ordinary lever and drive the various equations or expressions expressing the relation of the various quantities involved.

Let Fig. 1 represent a lever of length (l), the length of the two arms being (*a*) and (*b*). Let (P) be a force acting at the end of (a) and (p) be a force acting at the end of (b). (*o*) is the fulcrum point or fixed point. The moment on the left hand end of the lever is P×a, P being the force and (a) the shortest distance from the line of action of (P) to the center (*o*) or fulcrum. The right hand moment is ($p \times b$) where (p) is the force and (b) the shortest distance from the line of action of (p) to the fulcrum (O). The moment $(p\times b)$ turns or tends to turn in a right hand or clock-wise direction and is generally called (+) or positive, while the moment $(P\times a)$ turns or tends to turn in the opposite direction and is called a (—) or negative moment. In order to fulfill the requirements of equilibrium we have $p\times b=P\times a$ (1)

$$\text{or } P=\frac{p\times b}{a} \quad (2) \quad \text{or } p=\frac{P\times a}{b}.$$

Throwing equation (1) into the form $\lessgtr m=o$ we have $p\times b-P\times a=O$ which is the algebraic sum of all the moments. Equation (1) admits of finding either of the quantities a, b, P or p when the other three are given and apply when the lever is stationary or revolving about (O) at a constant rate. Let us now assume that the lever is stationary and horizontal and that the forces (P) and (p) are known and act vertically, and that the value of the force (F) at (o) is desired. Since the lever is in equilibrium the algebraic sum of the vertical forces must equal zero, we have $(F=P+p)$ or $F-P-p=o$ which fulfill the expression ($\lessgtr$ P=o). The value of (F) may be found by the use of moments if we will assume that the fulcrum or reference point is transferred to the end of the lever, say at (O'). Then we will have $(p\times l=F\times a)$ or

$$F=\frac{p\times l}{a}.$$

In Fig. 1 the forces (P) and (p) were assumed to act vertically or at right angles to the center line of the lever. This is really a special case and so let us now consider a general case where the forces take any direction at some one position of the lever. Fig. 2 represents such a case. Here the right hand or (+) moment is represented by $(p\times o)$, (od) being the shortest distance from the line of action of (p) and the center or fulcrum (o), the angle $od\ F$ being 90°. The left hand or (—) moment is represented by $(P\times oc)$, (oc) being the shortest distance from the line of action of (P) and the center (O). The finding of the valve and direction of the force (F) acting at the center (o) will not be considered at present as it involves what is known as the parallegram of forces which will be considered after the fundamental mechanical movements have been discussed.

Fig. 1

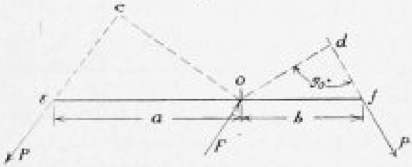


Fig 2.

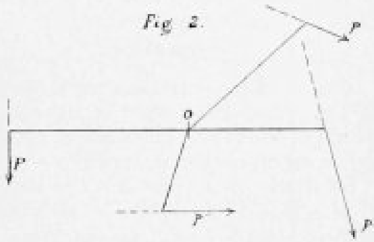


Fig. 3.

Fig. 3 illustrates a lever with four arms and acted upon by four forces, one at each of its various arm ends, thus dealing with four moments about the center or fulcrum (o). The expressions representing the relation of the moments in this case are derived as in the cases of Figs. 1 and 2, i. e., by following the expression $\lessgtr$ m=o.

The analysis of Fig. 1 also applies to a train of gearing, since a train of gears is really nothing but a system of revolving levers, either simple or compound, and the fulcrum points are the gear centers and the arms (a) and (b) assumed to be the radii of the pitch circles. The forces (P) and (p) being taken as acting perpendicular to the radii or tangent to the pitch circles. So if we know the force applied to one gear we can determine the force on the teeth of all others in the train, thus obtaining data for calculating the size of the teeth, arms, etc. The analysis of any system of levers, gears, etc., is the easiest kind of a problem if we work step by step, with the definitions of the various terms in mind and follow the meaning of ($\Sigma m=o$).

We will next take up the other mechanical motions or leverages that are often looked upon as being more complicated than the ordinary lever. We shall see that all mechanical motions are special cases of the lever, no matter what mechanism we consider, they all sift down to ($\Sigma m=o$).

Elementary Course in Mechanical Drawing.

(Continued from December Issue.

SINCE Plate IX. was not given in the December number of The Draftsman the problems are repeated.

PLATE IX.—Problem I.

In Fig. 1, *ab* is the side view or elevation of a 3 inch circle. Draw the plan or top view.

ab is $5\frac{1}{2}$ inches below the top border line of the sheet, the center *O* is 2 inches from the side and $2\frac{1}{2}$ inches from the top border lines.

Problem 2.

Fig. 2 is an elevation of a *frustum* of a 2 inch circular cone, 3 inches high, which is cut off 2 inches above the base by a plane parallel to its base.

Find the plan view and the location of an element (that is, a line on the surface of the cone drawn from the apex to the base).

The element makes an angle of 45° with the axis in the plan. Then a plan or top view would be projected above the elevation, when using the third angle method, and the plan will appear as if the cone had been crushed flat.

Any *element* as *xy* may be shown in the elevation by projecting down from the plan with lines perpendicular to *mn*, cutting *po* and *mn* in x' and y', in the upper and lower faces of the frustum

The elements of a cone between the bases of a frustum are equal and any one is called *the slant height of the frustum.*

Problem 3.

In Fig. 3, is shown only the plan of a hexagon prism, which is $2\frac{1}{2}$" across points and 3" high in the elevation which the student is to produce.

O is $1\frac{3}{4}$" from the top border line and $8\frac{3}{4}$" from the one on the left. The base of the elevation of the prism to be on a line with bottom of Fig. 2.

Problem 4.

In Fig. 4, a circular cone $2\frac{1}{2}$" in diameter and 3" high is cut by a plane 1" below the apex, the cutting plane making an angle of 30° with the base. *O* is $1\frac{3}{4}$" from the top and $4\frac{3}{4}$" from the right border line of the sheet. Base of Fig. 4 is on same line as the bases of Figs. 2 and 3.

Draw a given number of elements in the plan view and project to the base of the elevation and connect to the apex, as shown.

These elements cross the plane *mn* in several points as 1, 2, 3, 4, 5 which when projected to the plan cut the elements in points 1', 2', 3', 4' and 5' and in 1", 2", 3", 4" and 5", which are points in the curve representing the top view of the shape produced by cutting a cone with a plane *mn*.

Project the elements *co, fo,* etc., to the side view and connect to the apex as shown.

To find the points in the elements in the side view, take o"7'=o'7 and project to 7". o"8'=o'8 and project to 8". o"9'=o'9 and o"10'=o'10 and so on until all elements in the side view are crossed by points.

Point 3' and 3" is found in the top view by taking a circle of radius 3-10.

Problem 5.

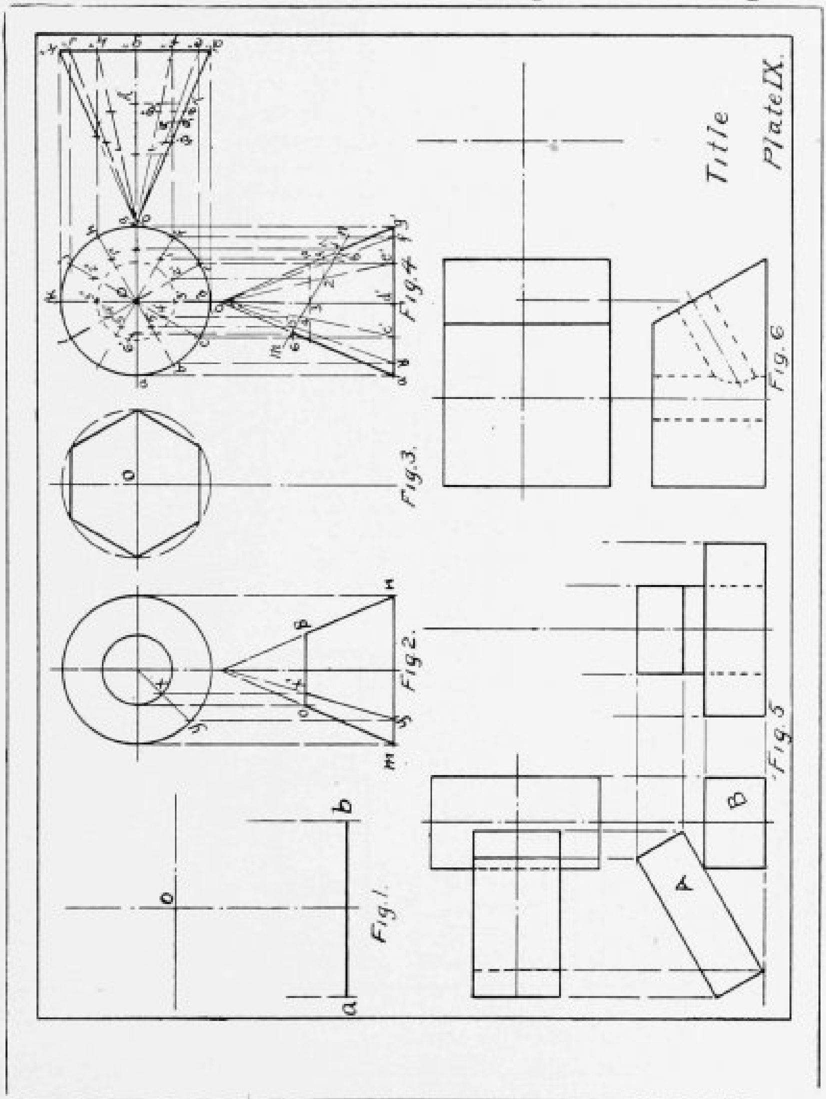
Two blocks are so placed that one lies on the other at an angle of 30°. Block *A* is $1\frac{1}{2}$" wide, 1" thick and 3" long. Block *B* is the same size, is laid with its center 3½" from left border line and the center of the side view is 7" from the same border. The center of the top view is 4¾" from bottom border line while the base of block *B* is ½" from that line.

Draw views as shown, then produce a top view of the right view of *A & B*, getting such lengths as are necessary from the present top and side views.

Problem 6.

Draw a truncated prism, lying on its long side, which is 4".

The right side is at an angle of 60° and the block is 2" high by 3" wide. Through the center of the top face is a ¾" hole and one of the same size perpendicular to the slant face at a point ¾" from the top.



Finish the top view, also an end view of this top view on the center lines shown and show the holes as they will appear in these views.

PLATE X.—Problem I.

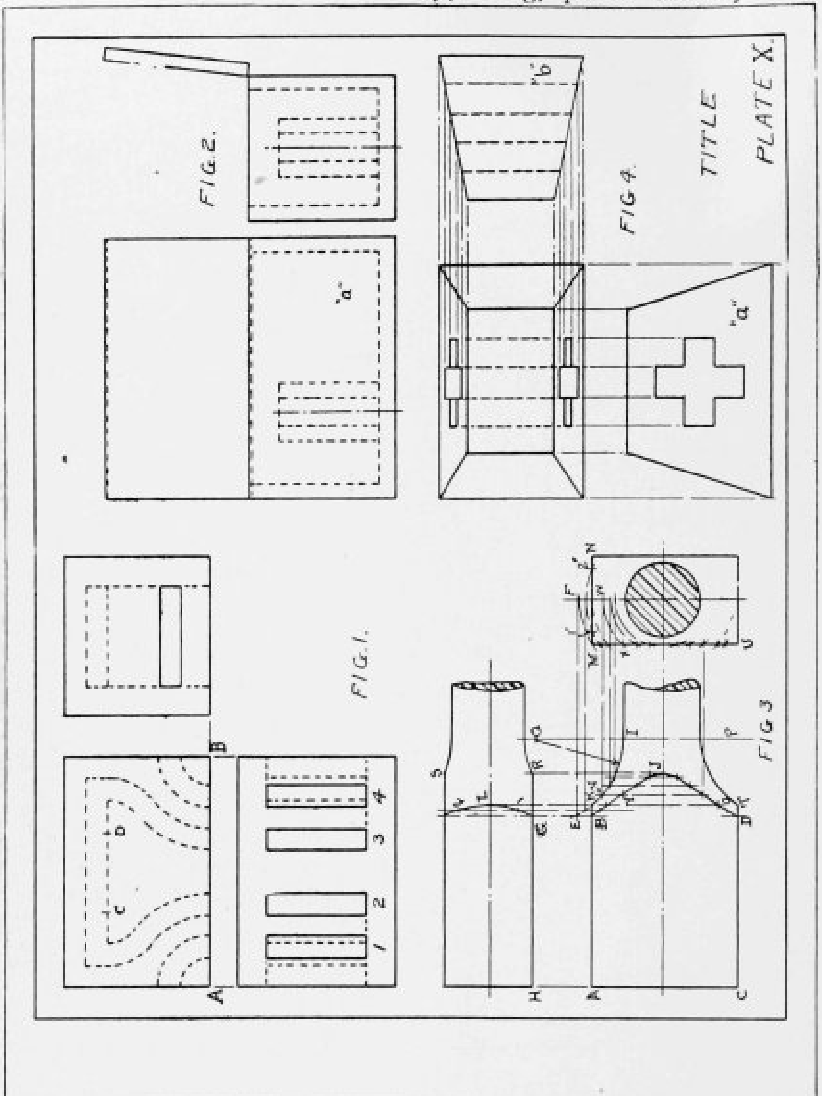


Fig. 1 represents a rectangular block with a number of curved slots cut through it. The view shown at *"A"* should be laid out first and the curved slots located. *b* and *c* may then be found by projecting from *"A."*

The size of the block will be 4" long, 2¾" wide and 2½" deep.

The size of the slots will be ⅜"x 1¾" long, placed centrally of the lower view.

Slots No. 1 to 4 are ½" from the ends. The curves are drawn with a radius whose center is located at *A, B, C, D* and the smallest being ½".

Problem 2.

Fig. 2 shows three views of a rectangular box with a cylinder placed in one end and the lid of the box raised to make an angle of 15° with the vertical side of the box. Lay out the view at *"A"* and the other views may be found from it.

Box to be 4½" long, 2½" wide and 2½" high and ¼" thick. Bottom line of box 6" from top border line and view *"A"* set with 3½" from right border line, cylinder is 1" diameter, 1¾" long and has ½" hole in it, and is set centrally in the end view, but off the center ¾" in the front view.

Problem 3.

Fig. 3 shows three views of the end of a common form of engine connecting rod. The rod is 1¼" in diameter and ends in a rectangular piece whose sides are parallel.

AC is 2½", *MN* is 1½" and *HG* is 3". Draw front end and top views as shown, making *HAC* ½" from left border line and *CD* ¾" from the bottom one. Center line of top view should be 1¾" from *AB* and center line *F* should be 6¾" from *AC*.

Draw projection line *BG* and extend to *D*, then rotate corner *M* to *F* and project *F* to *E* on line *BG*.

With a radius of 1½", draw an arc through *E* and tangent to the rod at *I*. Produce line *QIP* and strikes arcs in top view and side views and extend *CD* to *T*, *AB* to *K*, *HG* to *R* and likewise the line to *S*.

Draw in a few lines crossing the front and top view and cutting the curve *EKI*, project these points to line *F*. Revolve them to line *MU* and project back to their respective lines, thus *V* to *W* around to *X* and then back to *Y*.

Project *R* down to *J* and *K* to *L*.

By the above arrangement, points in the curve *BYJOK* may be found. Points 1-2 in the top view are found from 1'-2' in the end view.

Draw in the curves with a French curve.

Problem 4.

Fig. 4 represents three views of a truncated pyramid with a hole in the form of a cross cut through it in one direction.

The view shown at *"A"* should be laid out first and the others may be found by projections from it as indicated.

The object has a bottom face of 4"x2½" and the object is 2½" high. Also a top face 1"x 2½".

In view *"A"* the cross is up ½" from bottom and is 1½" long, each division being ½" each way, hence in view *"B"* the dotted lines are ½" apart.

CHAPTER V.—Sections.

If we should pass a plane through an object in any direction, and remove the part of the object which was in front of the cutting plane, and then project what was left of the object behind the cutting plane, upon a second plane, parallel to the first, the view thus shown would be a *section*.

Sections are taken to show the internal shape of objects and are often necessary in practical working drawings to clearly represent what is not shown by the other views.

The principle of *sections* may be studied by the use of simple geometric solids.

Reference has already been made to sections in Chapter I, under the head of "Section Lining," but nothing is given except the proper lining for the different materials used in mechanical work.

In practical working drawings, the objects are often shown entire in one view and in section in another, and the position of the section should be indicated by a dot and dash line in the view in which the plane of the section is seen edgewise, but if the view represents the object when the part in front of the cutting plane is removed, the line of the section should be represented by a full line upon the object.

It is customary to show the surface cut by the plane by "cross hatching" it with parallel equidistance lines as shown in Chapter 1.

Often the draftsman will make the shape of a section right on the object itself, as if it (the section) was revolved on its axis into the plane of the

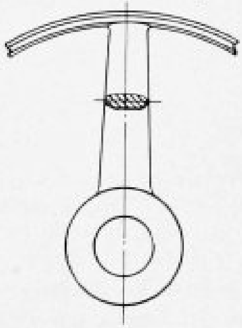


Fig. 1.

paper as in the case of a pulley arm, Fig. 1, or a yoke for a valve, the latter being shown on Plate XIII. The object should be drawn to the size of the dimensions, which may be placed on the drawing if desired.

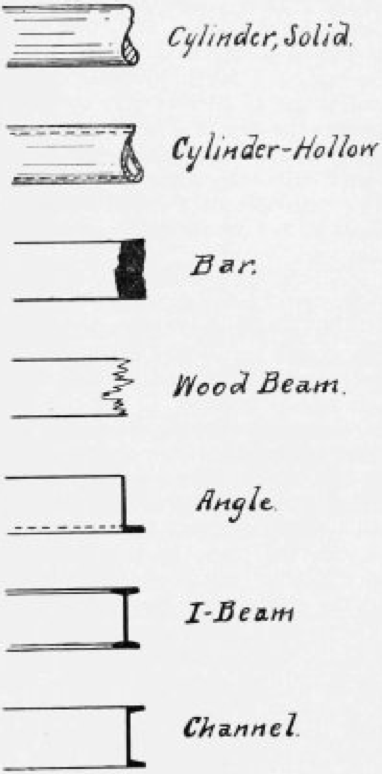


Fig. 2.

The shapes used in mechanical work are often broken and a section shown

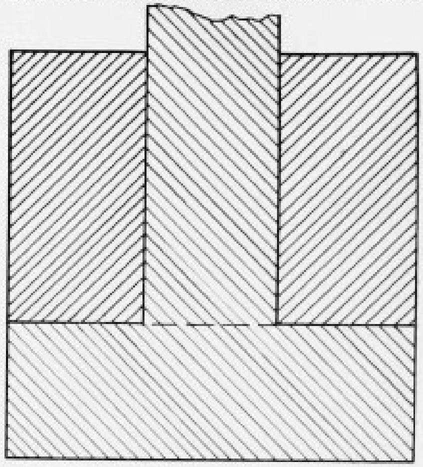


Fig. 3.

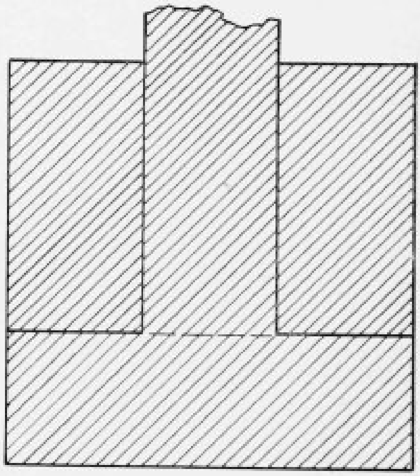


Fig. 4.

as in Fig. 2, so to more clearly represent their true character.

When a section of an object appears in more than one view, the "cross hatching" should be in the same direction for that part and when one or more parts are sectioned the "hatching" should be as in Fig. 3 and not as in Fig. 4.

When the plane of the section passes through the axis of a bolt on shaft, it is customary to let the bolt or shaft remain whole and it will then appear as a front view of the object, as in Fig. 5.

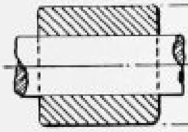
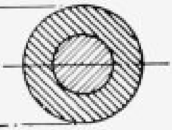



Fig. 5. *Fig. 6.*

If the section is at right angles to the axis, as Fig. 6, the bolt or shaft is sectioned according to the material of which it is made.

The simplest sections are those of the sphere every section made by a plane, whose diameter may vary from the diameter of the sphere to that of a circle as small as can be imagined.

PLATE XI.—Problem 1.

To show a section of a 2" sphere made by a horizontal plane ⅝" above the center.

The plane cuts the elevation *C* in 1-2 and in projecting to the top view, points 3-4 are found on the center line. A circle of diameter 3-4 will be the view of the section.

Center of circle *"C"* placed 2½" from left border line of the plate and 4½" from the top.

Place the section directly above, using center lines and "hatching" as shown.

Problem 2.

The section of a cylinder varies with the position of the plane, it is a circle, a rectangle or an ellipse, according as the cutting plane is perpendicular, parallel or oblique to the axis.

In Figs. 2 and 3, the cylinders are 3½" long and 2" in diameter, the cutting plane being 2" from the bottom in Fig. 2 and ¾" from center in Fig. 3.

In Fig. 4, the section is an ellipse which appears as a straight line in the front view and as a circle in the top view, its real length being seen in the front view. Then the true view of the section will be projected perpendicular to its face, at *FC*. The width 1'-2' is found from 1-2 in the top view and any line as 3'-4' will be taken 3-4 in the top view.

To obtain other points, locate any point, as 5, and project it to the top view, finding 6-7, then lay it off on 6'-7' on the section, projected from 5 perpendicular to *AB*. Proceed the same with other points and draw in the outline of the section with a French curve.

Make the cylinder 2" and let *DA* be 1" with *AB* drawn at 45. The center of the section *FG* should be about 3" from *AB* and parallel to it. Center of cylinder 2½" from right border line. *AB* may be divided into eight parts if desired.

Problem 3.

Pass a plane through a cone parallel to one side and show the true shape of the section, also a top view, Fig. 5. Cone to be 2" diameter and 3" high, plane to be passed ¾" from the side.

The front and top views are on a central line 2½" from the left border, the front view being 1" up from the bottom border line of the sheet.

Locate cutting plane and project to top view as shown, in 1'-2'. The center line of the section is to be 2½" from the cutting plane, the 1"-2" being 1'-2' in the top view. Draw several section lines as 3-4, 5-6, etc., project 4, 6 and 8 to line *AB* and draw in the curves, drawing lines through top view, cutting the circles, from the intersection of the cutting plane and lines 3-4, 5-6, etc., in the front view. The lines of the section view, perpendicular to *CD*, are 5"-6"=5'-6', etc. from the top view. Find the points in the top and section view and draw the shapes with the French curve.

Problem 4.

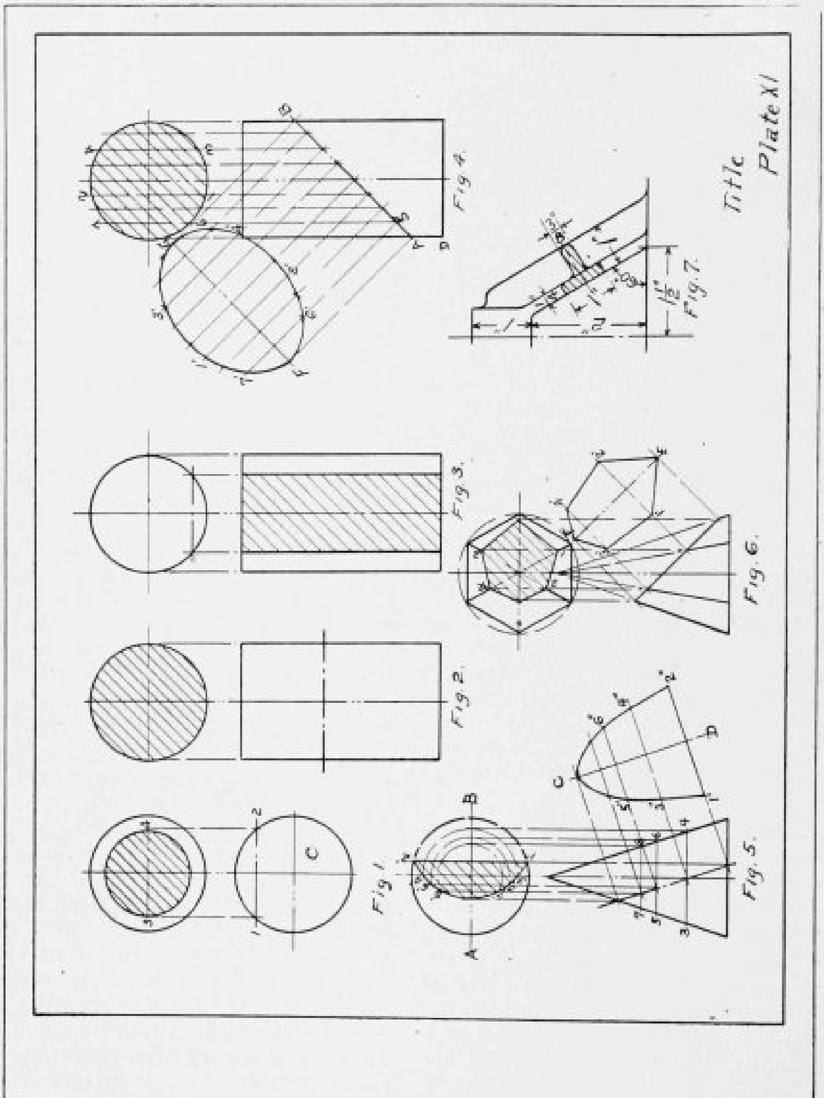
Pass a plane, at an angle of 60° with the horizontal through a hexagonal pyramid and show a top view of the section, also its true shape, Fig. 6.

Long diameter of hexagon 2", pyramid 3" high, center of section view *EF*, 2" from cutting plane, which cuts the pyramid 1¼" up from the base on the center line. Project to top view and connect the points on the diagonal lines, 1, 2, 3, 4, etc.

Lines 1'-2' and 3'-4' are the same as 1-2 and 3-4 in the top view. Draw in the outline of the shape of the section.

The top and side views may interfere some if the space does not permit Fig. 6 to go in without cutting into Fig. 3.

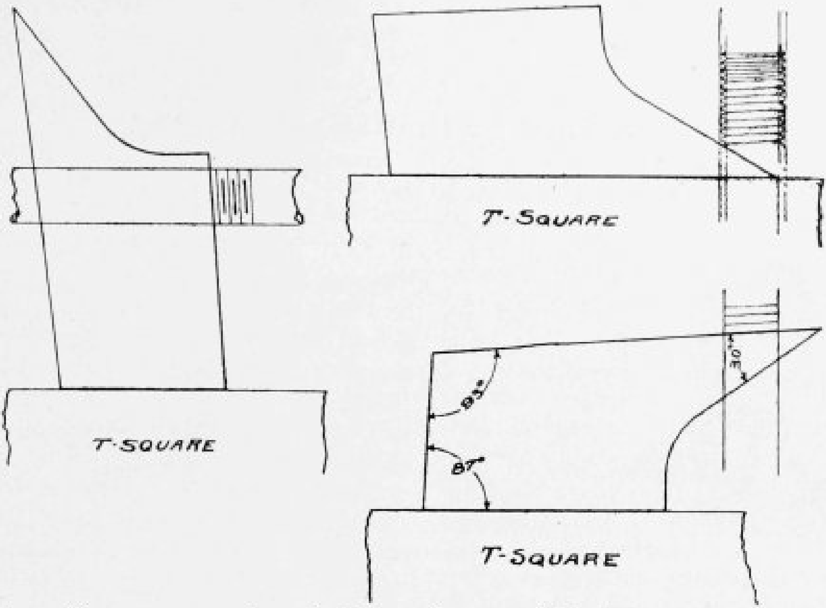
The base of Fig. 6 is 1" above the border line and center line is 8" from left border line.



Problem 5.

Show the valve yoke, Fig. 7, and the section as shown, using the dimensions and locating the center 5" from right border and 2½" up from the bottom line, thus leaving room for the title of the plate.

A Handy Triangle.



Some time ago a reader of "The Draftsman" sent in the following sketch of a handy little triangle, though not a triangle it is handled in the same way,

The sketches will no doupt explain its use in one respect though several other angles might be arranged for if the material is large enough. It was made from a piece of an old triangle and was cut and trued up to the proper angle,

The name of the designer of this instrument is desired so he may get the full credit for this article and sketch.

New Expansible Steel.

One of the most remarkable and valuable properties of nickel-steel is revealed by the discovery of the French scientist, Guillaume, that when the proportion of nickel in the alloy is a little above 36 per cent., the coefficient of expansion, with rise of temperature, sinks to the lowest point known for any substance. Indeed, M. Guillaume avers that a nickel-steel can be made with no coefficient of expansion at all. Experiments in this country have resulted in the production of nickel-steel with so slight a degree of expansibility that in practical work it can be entirely neglected. The usefulness of such a material for making instruments of precision is evident. But at present the cost of making the alloy is too high for its employment in building and the manufacture of heavy machinery.—Science.

CURRENT TOPICS.

Mr. "Joe Cone" a Draftsman and Poet.

Joseph A. Cone, or "Joe Cone," as he is best known, the subject of this sketch, was born in Moodus, Conn. November 13, 1869. Moodus is a lively country town in which are located 14 cotton twine mills of national repute.

Here is where Mr. Cone made his start in the mechanical life. Until 18 years of age he by turn went to the little village school, worked on his father's farm and in the mills. His first real trade was that of printer, then at the age of 20 he entered the construction department of the American Net and Twine Co., (a branch of which was then located in East Haddam, Conn., near Moodus,) as apprentice. With this firm he has remained ever since, going to Boston when the plant was removed in 1890.

Immediately on his removing to Boston he entered the Cambridge, Y. M. C. A. night schools, winning three diplomas in three years, after which he became a member of the American School of Correspondence. Being persistent in his studies, and aiming only for the highest he has risen to the position of chief draftsman and designer of the American Net and Twine Co., a corporation employing between 600 and 1,000 persons. In addition to this he is head instructor in Mechanical Drawing and Machine Design at the Cambridge Institute.

Born with a love for literature Mr. Cone has gratified his tastes in that direction to the extent of contributing to the leading journals and magazines of the country, many of his contributions appearing in the columns of The Draftsman. He has also published a volume of successful verse, "Heart and Home Ballads," is literary editor of "The Suburban," a well-known Boston weekly, and is a member of The Harvard Union.

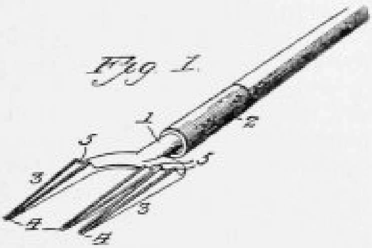
As an inventor, designer and draftsman, Mr. Cone is well known in the netting manufacturing business. He resides in Cambridge, Mass.

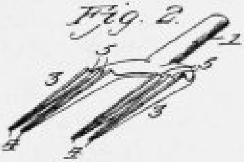
The Illustration in this article is gretited to the "Four Track News."

A New Ruling Pen.

THIS invention relates to improvements in ruling-pens; and the object is to provide an improved multiple ruling-pen by means of which a number of parallel lines may be simultaneously drawn with the same ease and facility with which a single line may be drawn with the ordinary construction of ruling-pen.

With the above object in view the invention consists in the novel features of construction.





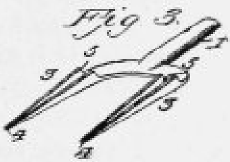


Figure 1 is a perspective view of one form of my improved pen in connection with a suitable holder, and Figs. 2 and 3 similar views of different forms of the pen.

Referring now more particularly to the drawings, 1 designates the shank of the pen, shaped at one end to fit in an ordinary pen-holder 2 and carrying at its opposite end a fork-shaped portion the forks 3 of which are formed each with one or more ruling-points 4. As illustrated by the drawings, the shank, forks, and points, together with the usual ink-reservoir 5 for each point, are formed from a single piece of metal.

In Fig. 3 is shown the pen provided with one ruling-point for each of the fork members, with which construction two parallel lines may be drawn with a single stroke of the pen. In Fig. 2 the pen is provided with two points for each fork, so that four parallel lines may be simultaneously drawn---that is, two sets of two lines each, the lines of each set being comparatively close together and the two sets being separated at a greater distance from each other.

Fig. 1 illustrates a pen having one of its forks provided with one ruling-point and the other fork with two points. With this pen three parallel lines may be drawn at each stroke, two of them being arranged comparatively close together and the third one at a greater distance.

The number of ruling-points carried by each fork and the relative arrangement thereof may be varied to adapt the pen for different kinds of work without departing from the scope of the invention.

From the above description it will be seen that here is produced a very simple construction of ruling-pen which will be especially useful to accountants, bookkeepers, draftsmen, and others.

Farm laborers in Mexico may be employed at from eighteen to twenty cents a day, though in many parts of the country they are scarce and unreliable.

MATHEMATICAL.

"Can you put two and two together?"

"Not so well as one and one; I'm a minister."—Detroit Free Press.

Discovery of Dynamite.

Terrible Explosive First Prepared by an Italian Chemist in the Year 1845.

Few people know what dynamite is, though the word is in common use, says the American Syren and Shipping Journal. It is a giant gunpowder; that is, an explosive material, varying in strength and safety of handling according to the percentage of nitroglycerin it contains. Nitroglycerin, whence it derives its strength, is composed of ordinary glycerin and nitric acid, compounded together in certain proportions and at a certain temperature. Nitroglycerin, though not the strongest explosive known, being exceeded in power by nitrogen and other products of chemistry, is thus far the most terrible explosive manufactured to any extent. Nitroglycerin by itself is not safe to handle, hence dynamite is preferred.

It is extensively made and consumed in the United States under the various names of Giant, Hercules, Jupiter and Atlas powders, all of which contain anywhere from 30 to 80 per cent. of nitroglycerin, the residue of the compound being made up of rotten stone, nonexplosive earth, sawdust, charcoal, plaster of paris, black powder, or some other substance that takes up the glycerin and makes a porous spongy mass.

Nitroglycerin was discovered by Salvero, an Italian chemist, in 1845. Dynamite is prepared by simply kneading with the naked hands 25 per cent. of infusorial earth and 75 per cent. of nitroglycerin until the mixture assumes a putty condition not unlike moist brown sugar. Before mixing the infusorial earth is calcined in a furnace in order to burn out all organic matter and it is also sifted to free it of large grain. While till moist it is squeezed into cartridges, which are prepared of parchment paper, and the firing is done by fulminate of silver in copper capsules provided with patent exploders.

Nitroglycerin is made of nitric acid one part and sulphuric acid two parts, to which is added ordinary glycerin, and the mixture is well washed with pure water. The infusion is composed of small microscopic silicious shells which have lost their living creatures. The cellular parts receive the nitroglycerin and hold it by capillary attraction, both inside and out. The earth is very light. Water is expelled from it by means of a furnace and then in the form of a powder it is mixed with nitroglycerin. Nitroglycerin has a sweet, aromatic, pungent taste, and the peculiar property of causing a violent headache when placed in a small quantity on the tongue or wrist. It freezes at 40 degrees Fahrenheit, becoming a white, half-crystallized mass, which must be melted by the application of water at a temperature of 100 degrees Fahrenheit.

In Reference to "The Drafsman"

Many good articles are being prepared or the pages of The Draftsman of which the following are a few:

Plane Trigonometry, its theory, application and use by Reed R. Lewis, C. E. This will be the forepart of a number of articles showing its application to engineering work and any draftsman or student can follow them.

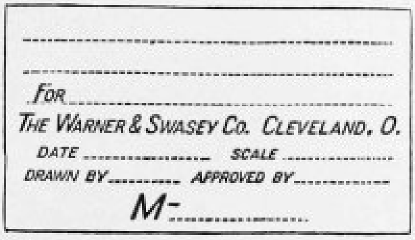
Several articles to come on Elementary Mechanics, also Elementary Architectural Design.

Illustrating Mechanical Literature will appear in the February issue.

Many new inventions of interest to The Draftsman's readers.

A New Rubber Stamp for Drawings.

Taylor Bros. of Cleveland have recently made a neat stamp for marking



tracing so to save the time of the draftsman in finishing a drawing.

The border line is 2⅛"x4¼" which is really large enough to enclose the data needed as a title. This firm furnish an "opaque ink" on pads for printing on tracing cloth with rubber stamps and will look after your orders carefully.

Transparent Paper.

THERE are several methods of rendering paper transparent. Coat white paper with a solution of Irish moss in water, to which a slight quantity of previously dissolved gelatine has been added. It should be applied hot to the paper. When colors are desired they must be transparent; they must be ground in varnish, and a stronger varnish is required than for opaque colors. A fine yellow may be produced by using yellow lake and red sienna. These make a warmer color than the yellow lake alone. If cost is no objection, aurasine may be used. For pale red, madder lakes should be employed, but for darker shades crimson lakes and scarlet cochineal lakes. The vivid geranium lake gives a magnificent shade, which, however, is not at all fast in sunlight. The most translucent blue will always be Berlin blue. For purple, madder purple is the most reliable color, but possesses little gloss. Luminous effects can be obtained with the assistance of aniline colors, but these are only of little permanence in transparencies. Light transparent green is hardly available. Recourse has to be taken to mixing Berlin blue with yellow lake or red sienna. Green chromic oxide may be used if its sober, cool tone has no disturbing influence. Almost all brown coloring bodies give transparent colors, but the most useful are madder lakes and burnt umber. Gray is produced by mixing purple-tone colors with suitable brown, but a gray color hardly ever occurs in transparent prints. Liquid siccative must always be added to the colors, otherwise the drying will occupy too much time. After the drying, the paper must be varnished on both sides. For this purpose a well-covering, quickly-drying, colorless, not too thick varnish must be used, which is elastic enough not to crack nor to break in bending.—English Mechanic.

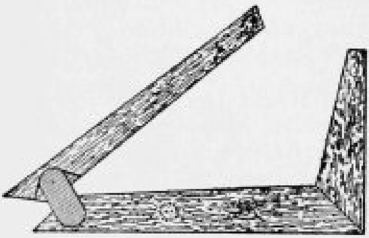
By a new Dutch process it is claimed that a moose hide can be turned into leather ready for the saddler's and shoemaker's use in from one to three days, while by following the usual method of preparation it takes about six months.

Metal Corrosion.

The corrosion of metals by sea water has been investigated by a German engineer named Diegel. Alloys of copper and nickel are not very rapidly corroded, and are rendered more immune by adjacent masses of copper alloys, iron or copper, these protectors being then more rapidly corroded. Copper-zinc alloys are corroded either by a uniform solution of the alloy from the surface, or, when the zinc exceeds 24 per cent., by a leaching out of the latter, but by the addition of 15 per cent. of nickel this action is prevented. The corrosion of copper pipes in vessels is often very rapid, and occurs frequently at bronze joints, but the experiments show that a high amount of arsenic (over five per cent.) in the metal greatly retards the decay. When two pieces of iron differing in phosphorus contents were in metallic connection the sea water corroded the low phosphorus iron from two to five times as fast as the other. The normal corrosion of single plates of metal was less as the percentage of nickel increased, and when two plates differing in nickel contained were in contact the plates higher in nickel was almost completely protected from corrosion.

The Duplex Angle.

The Duplex Angle is practically a right angle triangle with a movable



hypotenuse, the joint of which will retain, by friction, any angle to which it is set.

It is therefore, especially adapted for transferring a copying angles.

As the angle flush on both sides, it can be used for drawing equal angles in opposite directions, a great advantage in drawing roof pitches, teeth of gear wheels, sides of taper, arms of wheels, polygons, etc.

The Duplex Angle is one of the many useful instruments placed on the market by the Keuffel & Esser Co., 127 Fulton St., New York, who will be pleased to mail circulars and prices to our readers.

A New Rubber Substitute.

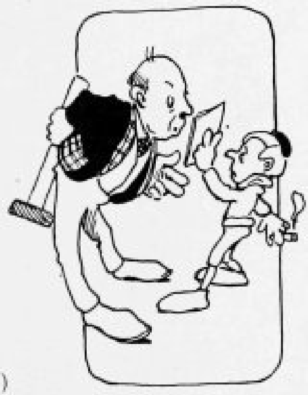
Gutta-joolatong is a comparatively new material which is utilized as a substitute for and in conjunction with india-rubber. It is a product of the East Indies, chiefly the island of Borneo, and in the form in which it is imported is described as "whitish in color, looking something like marshmallow candy, smelling strongly of petroleum and oxidizing on exposure to the air, becoming hard." The same description says: "It is not a substitute for gutta-percha or india-rubber, but is used chiefly as a filler in manufactures of india-rubber gum and gutta-percha." Its importation has increased from 6,500,000 pounds in 1899 to 14,000,000 pounds in 1903.

Cleveland Man's Big Job

The task of a former Cleveland railroad man, Ira A. McCormick, formerly general manager of the Big Consolidated, in supervising the equipment of the New York Central tunnel from Mott Haven to the Grand Central station in New York city with electricity, promises to be one of the largest undertakings in electrical history. The plans of the company embrace an expenditure of about $10,000,000, and the equipment of the tunnel will require motor engines sufficient to move all the trains on the New York Central and New Haven roads from the Manhattan station to the Mott Haven station and the handling of the trains in the Manhattan yards. When the plans are worked out and completed the motors will take each train at the Mott Haven station to the Grand Central station and bring them back. The plan will do away with all smoke, gas and fumes and prove an innovation in railroad transportation in the congested districts. Mr. McCormick is experienced in electrical work and the success of the undertaking is practically assured.

"He Saw it on the News Stand"

Mr. Architect (angrily) "I'll wollop the hide off of that boy of mine for staying out late at night. I,ve warned him before about it. Here he comes now!"



Willie (hopelessly) "S—s—say paw here is a copy of "The Draftsman which I saw on the News Stand,"

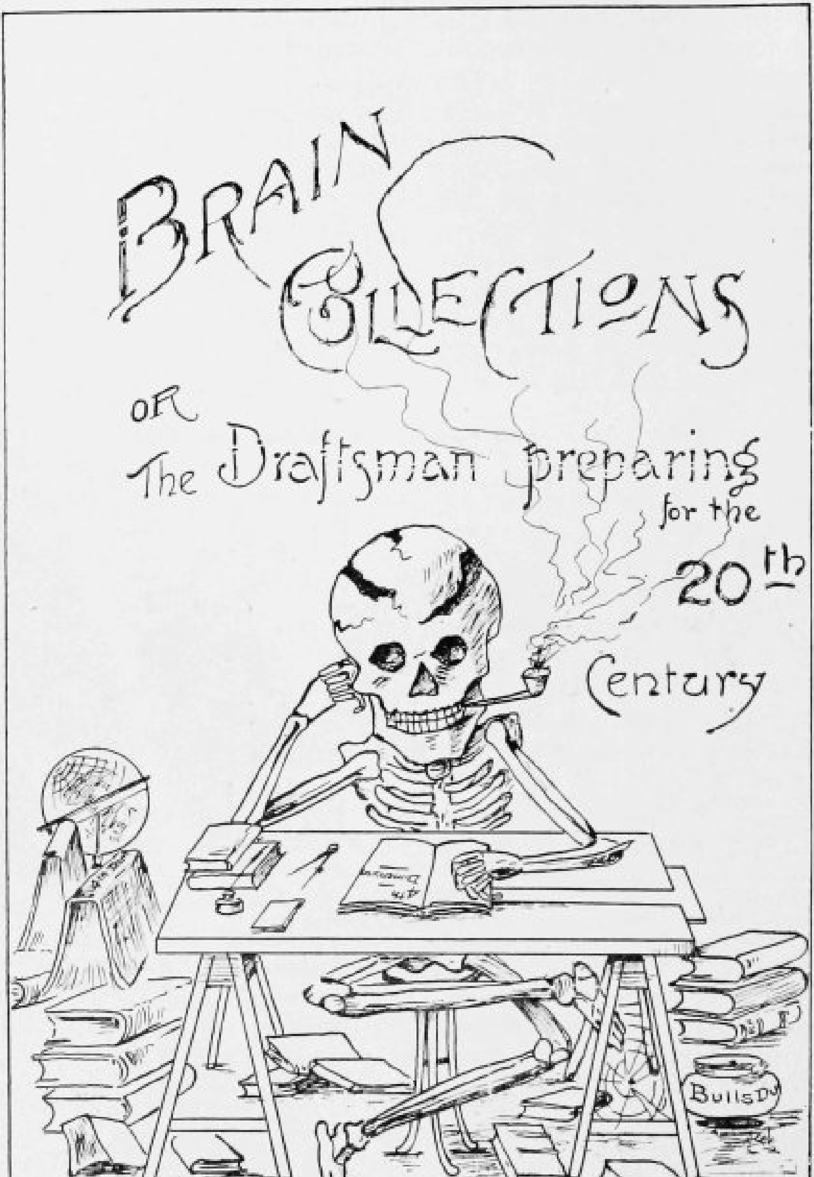
Architect (musingly) "Well—well ah, h,m er'e thank you my boy—thank you."

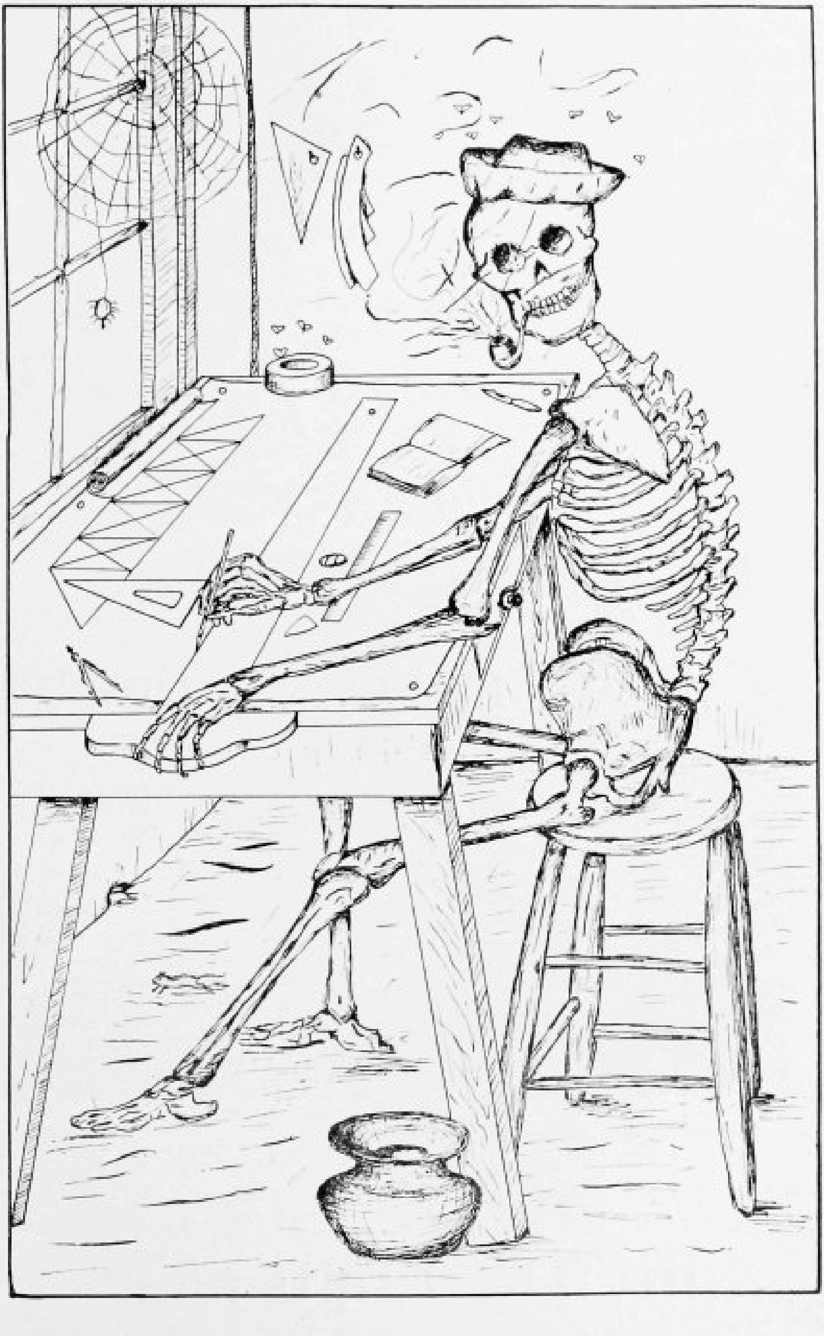
The $2,142,207 worth of platinum extracted in the Gorotiagodatski district of Russia last year is practically the world's supply of that metal.

A scheme has been prepared for carrying out an underground railway in Manchester, Englan, which connections with the principal out districts.

A Slur at the Profession.

Some artistic fellow makes up the following illustrations as the future of the draftsman but they will never come to this—they move to often, at least that is what some employes think the draftsman thinks he can do better





so he moves on to another job.

This may be his picture if he clings to old-time tools and methods. He should aspire to a better knowledge of the work (see Brain Collection) and to the use of the latest tools such as—well, we will say the Universal Drafting Machine.

Draftsmen do get thin studying, and the mental strain for eight hours is something to make a fellow nervous sometimes, too, yet the draftsman is the "man behind the gun" in one sense of the word.—he designs the gun.

Have you renewed your subscription for The Draftman? I'm just on my way to get the new January Issue, (See Scetch.)

Good Articles Coming!

The Design of Screw Propellers,
Notes on Shop Inspection,
Plane Trigonometry and its Uses,
Illustrating Mechanical Literature,
Pen Drawn Cover Designs,
The Design of a Simple Lever,
How to True up Triangles,
How to Straighten Paper,
Inventions of Drafting Appliances,
Sizes of Upset Screw Threads, Illustrated
Also continued Articles in Home Study and Architecture.

In "The Draftsman."

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Mechanical Drawing at Central Institute.

MECHANICAL Drawing at Central Institute is being conducted as practical as possible and the work is arranged to cover a period of three years if desired.

During this time, the students also take up the subjects of mathematics, physics, chemistry and mechanics, besides drawing.

Day and evening classes occupy the same rooms, so that the tables in the two drawing rooms serve for a great number of students.

The tables for the use of students in drawing are illustrated on another page and it will be seen that they afford ample locker room as well as working space.

This illustration shows the room used by those in elementary drawing in both the day and evening classes

(Continued on page 93)

MECHANICAL.

Preliminary Propeller Design.

CARL H. CLARK.

THE questions of size, pitch, surface and shape of the blades of a propeller are among the most difficult of those with which the Marine Engineer has to deal. The conditions under which propellers work are so different that great care is required in judging the action of one wheel from that of another.

The problem as usually presented is about as follows: The I. H. P. required to drive any hull at a required speed may be at least approximately determined in several ways, and the question is to so proportion the propeller as to economically use up this power. For a nice determination of the properties of the wheel any authentic data may be used. This data has been collected and presented in tabular form in "Barnaby's Marine Propellers," and also in several other books and papers.

If this data is not at hand it is desirable to be able to make a close estimate of the properties of the propeller. The surface may be figured from the thrust per square foot of area. The indicated thrust is given by the formula

$$\frac{I.\ H.\ P. \times 33.000}{\text{speed in knots} \times 101.3} = \text{indicated thrust}$$

Now the amount of thrust absorbed by each square foot of blade area is from 900lbs. to 1100lbs.; so that if the I. H. P. is divided by this quantity the total blade area is obtained—this arc must be so disposed as to diameter and number of blades, that the area shall not be too large in proportion to the disc area, or area of the circle described by the tips of the blades. The developed area is usually about 35 to 40 per cent. of the disc area, for four-bladed wheels and about 30 to 35 per cent. for three blades. This limitation will fix the diameter.

If the greatest immersed cross-section of the vessel is obtainable an additional estimate of the diameter is obtainable from the proportion of the disc area to the area of the greatest immersed cross-section. This proportion will be about 20 per cent. for slow vessels, about 33 per cent. for fast ships, and about 33 per cent. for vessels used for towing.

The revolutions per minute will be fixed by the I. H. P.; and, assuming that the given I. H. P. is sufficient to produce the given speed the pitch required can be readily figured, allowing a certain amount for slip. This slip in a well-designed propeller will vary between 12 per cent. and 20 per cent. with perhaps 16 per cent. as a fair average. Then—

Speed in knots $\times \frac{6080}{60}$ = speed in ft. per min.

$\frac{\text{feet per min.}}{\text{revs. per min.}}$ = advance per revolution

advance per rev.

$\frac{\text{advance per rev.}}{184}$ = pitch of wheel in ft.

The proportion of pitch to diameter, termed the pitch ratio, varies from 1.0 to 1.3. The final determination of these dimensions must be made such as to satisfy all the proportions reasonably well.

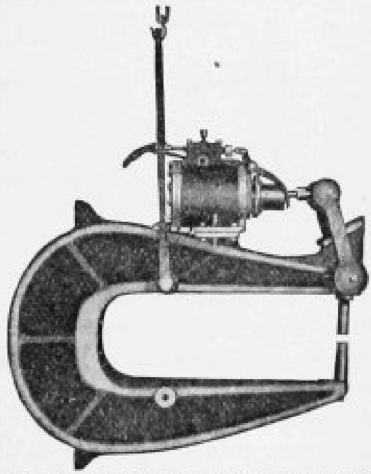
The above outlined method must be accompanied by practical experience, and when so used will give good results. The individual designer will usually have on hand a certain amount of data which he has collected from previous work. As a matter of fact it is not always possible to get the best propeller at the first trial, and many times it is necessary to make a second wheel, using the data obtained from the first, making whatever changes appear necessary.

The laying out of the propeller to the dimensions decided upon will be dealt with in the next issue.

The Allen Riveter.

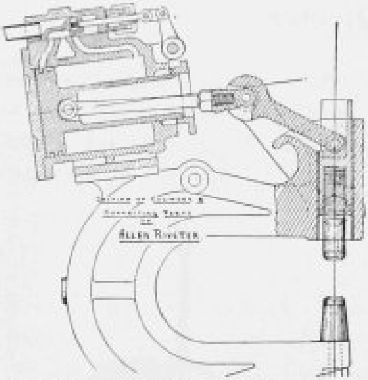
NO one of the modern improvements introduced into the structural, bridge and boiler making shops of this country deserves more attention at the present time than the portable riveting machine, a tool that is always reliable, is a great time-saver and one that can speedily accomplish work which it would otherwise be folly to undertake.

Prior to 1883 such a machine as a riveter was unknown, and it was at that time that Mr. Allen obtained the first patents on the machine, which has now come into such general use in boilermaking and structural iron working shops as to make one forget that it is a tool of comparatively recent invention. Since that date, the firm which bears his name has devoted its time to the perfection of his machine, and it now enjoys the reputation of embodying all the best principles of riveter construction with none of their defects. Several new features recently patented have now been added to the machine, which we shall attempt to describe in the space allotted.



As will be seen by referred to the illustrations, showing a sectional view and the machine complete, the piston rod connects levers of different length, forming a toggle joint. The lower ends of the larger levers are attached to fixed centers on the frame, which is of very rigid construction, and the end of the short central lever is attached to the ram, which has a die head screwed into the lower end, this arrangement allowing any desired change in the distance between the dies to be easily effected.

The middle link is connected with the piston rod by means of a steel crosshead, which has a phosphor bronze shoe. The side links, which fit over the trunnions on the middle link, are connected by a straight pin. In this way a double bearing is obtained and a direct leverage effected of a



unique type in riveter design. Tests have determined that a 12-inch cylinder of this construction with 80 pounds pressure will exert 75 tons pressure on the head of the rivet.

One of the most important features is the cut-off contrivance, which automatically covers the port in the cylinder when the machine is not in operation, thus preventing any possible leakage of air.

The machines may be operated by either steam or air, and they are so balanced that when suspended they can be operated either vertically or horizontally. The "jaw" riveter is so arranged that it will straddle the edge of girders and beams, having 6-inch angle irons on each side, and likewise operate in channel iron.

The Allen boiler riveter, which we also illustrate, consists of two levers, having at one end a pressure cylinder to open and close the levers, at the other end the riveting machine on one arm, and a suitable die with counter weight attached on the other arm. The long arms of the levers are made capable of reaching a rivet 72, 84 or 96 inches, respectively, from the edge of the plate, so as to operate upon the circular seams of a boiler.

The riveter works on the principle of hand work, forming the head of the rivet by a succession of rapid blows around the rivet until the desired shape of the head is obtained.

The machine is operated with an atmospheric pressure of from 30 to 40 pounds to the square inch, and makes from 150 to 200 strokes per minute. The time required to form the head of a ¾-inch rivet is about 6 seconds, and at steady, straight work, allowing for ordinary detention and loss of time, two or three rivets can readily be finished in one minute.

These machines are operated with less than half the number of men required to run a riveting machine where the work is suspended, and their simplicity makes skilled labor entirely unnecessary. — *"Ryerson's Monthly."*

Rig for Slotting Oil Grooves.

A CHEAP interesting rig for slotting oil grooves in bushings or cast iron bearings is shown in accompanying sketch as used by a western Yankee in a large manufacturing plant.

It is intended to do away with the work of chipping a groove in the box and also makes a better job when finished.

The bearing or box is illustrated in Fig. 2, showing oil groove which should not extend to the ends.

The jig is mounted upon the table of a slotting machine as is shown in Fig. 1.

When the slotter head and tool is at the upper end of its stroke, the box can be readily slipped over the slotted stud in the jig.

The back, inner surface of slot in the stud, forms the guide which operates the tool forward and backward. A small tool, held by a set screw is inserted into the tool arm, which is pivoted above allowing movement by guide.

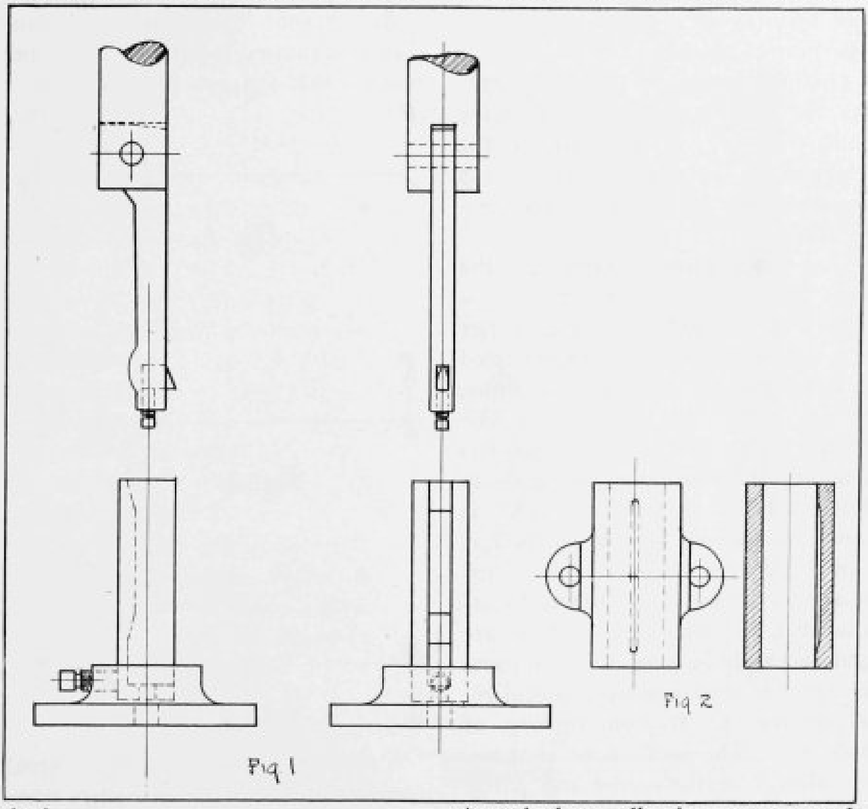


Fig 1

Fig 2

On the downward stroke of the head the tool arm enters the slotted stud and proceeds straight down until the tool has passed the end of the box when the cam on tool arm operates on guide which throws it forward to the required depth. One stroke only of the head is necessary to complete the cut.

H. MacDonald.

Elementary Mechanics and Lever Design.

A MACHINE is a device designed to transform and convey energy, and to do useful work.

An electrical power plant illustrates both features of a useful machine or collection of machines.

The heat energy of the steam actuates the moving parts of the engine which transfers the power to the armature of the dynamo, where it is converted into the energy of the electric current.

The effect force exerted by the agent losing energy and the force exerted by the body receiving energy in a simple machine may be denoted by two terms introduced by Rankine, namely *effort* and *resistance*. The problem in simple mechanics consists in finding the relation of resistance to effort and this relation or ratio is known as the *mechanical advantage*.

In elementary discussions, it is customary to neglect friction and to assume that the parts of a machine are rigid and without weight, but in practice there is always some wasteful resistance due to friction, rigidity of cords, etc. The work done is therefore always partly *useful* and partly *wasteful*.

If a machine could be made that would waste no energy, that is, one in which the resistance is all *useful* and not *wasteful*, the machine would be perfect and its *efficiency* would be unity.

The efficiency of a machine is the ratio of the useful work done by it to the total work done by it, and is always expressed as a percentage.

An efficiency of 90 per cent. means that the energy given out is 90 per cent. of that put into the machine.

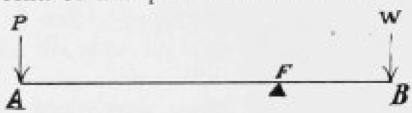


Fig. 1.

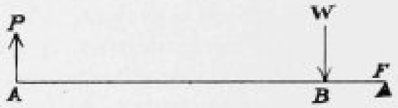


Fig. 2.

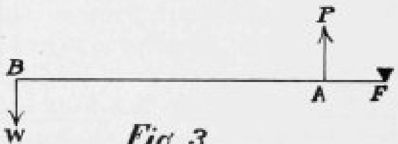


Fig. 3.

A machine which will give perpetual motion with no supply of energy from without is thus clearly impossible.

Simple machines are restricted to devices for merely transferring energy while *complex machines* areoften combinations of two or more simple machines or *mechanical powers*.

There are only six devices considered as simple machines, the *lever*, the *pulley*, the *wheel* and *axle*, the *incline plane*, the *wedge* and the *screw*. The pulley and wheel and axle are levers in different forms and the wedge and screw are modifications of the inclined plane; it is therefore possible to reduce the six to two, the *lever* and the *inclined plane*.

A *lever* is a rigid bar straight or curved, turning about a fixed center called the *fulcrum*.

The perpendicular distance between the fulcrum and the line of action of the effort and between the fulcrum and the resistance are called the *arms* of the lever as AF and FB in Fig. 1.

A straight lever is one in which the arms are in the same straight line.

A lever is said to be of the first class if the fulcrum is between the points of application of the force or effort and the resistance, Fig. 1; of the *second class* if the resistance or weight is between the fulcrum and the effort (Fig. 2); and of the *third class* when the effort is between the resistance and the fulcrum, (Fig. 3.)

The *common balance* is an example of the first class, equal arms, while the crow bar resting over a block with a weight at the outer end is of the same class, though of unequal arms.

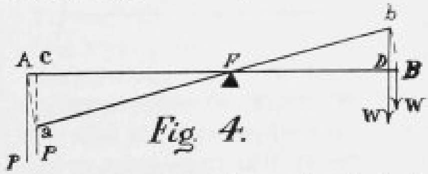
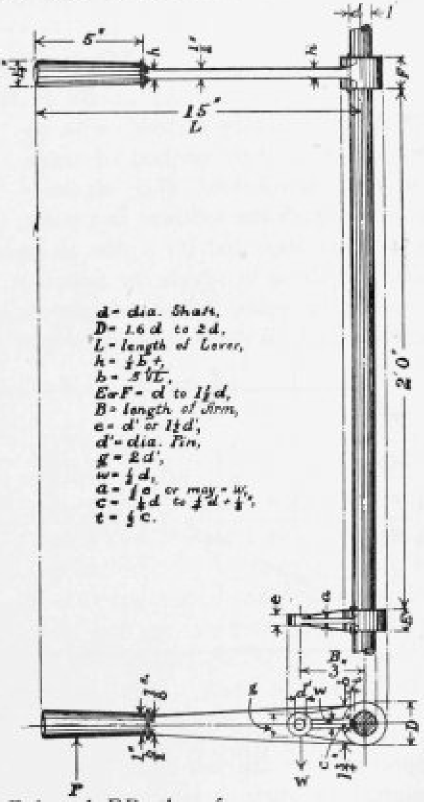


Fig. 4.

To demonstrate the *mechanical advantage* of the lever, let *AB* (Fig. 4) be a straight lever whose arms are *FA* &*FB* with *P* the effort and *W* the resistance or weight lifted. Tilt the lever into the position *aFb*, and neglecting friction of $P \times aC$ (effort multiplied by distance through which it moves) is the work done by the effort against $W \times bD$ of the resistance, $W \times bD$ being the weight multiplied by the distance through which it is moved.

Putting these equal to each other, $P \times aC = W \times bD$ but the ratio of the lines *aC* and *bD* is the same as that of the arcs *aA* and *bB*; and the ratio of the axes is the same as their radii *FA* and *FB*, therefore



$$P \times FA = W \times FB$$

The arm *FB* is often spoken of as the *purchase* that lever has and is applied to levers of the first class.

Suppose we say a man weighing 160 lbs works with a 6 ft. crowbar and used a fulcrum six inches from the end, what weight can he lift?

Then PA=5 ft.-6 in.=66 ft. FB=6 ft. P=160lbs.

160×66in.=K×6in.

10560=W×6.

$$W = \frac{10560}{6} = 1760 \text{ lbs.}$$

Now suppose we are to design a lever with which a man who can lift 100 lbs. can lift 500 at the end of an arm 3 in. from the center of the shaft, the arm and lever to be 2 ft. 0 in. apart.

Then Fig. 5 shows the arrangement of lever and arm with a table of proportions. Some of these are revised from Union's Machine Design, though it is suggested that *D* be twice the diameter of the shaft if the arm and lever are of cast iron and if so then ribs should be run along on the web of the lever to stiffen it.

The grip portion of the lever will be the same for any length if it is to be for the hand.

High Speed Cams.

By F. H. Sibley.

CAMS might be divided, with respect to their method of transmuting motion, into two classes—those in which the follower is a point, or a roller mounted on a pin as an axis, and those in which the follower is a bar or yoke, either straight or curved. Each of these divisions might be subdivided into two classes with respect to their use, into cams that are designed to work at low speeds and cams that are intended for high speeds. The operating machinery of some types of drawbridges, and metal shaping machines furnish examples of the first subdivision, sewing machines contain a good illustration of the second.

Cams are made in a great variety of shapes. For the method of laying out some of the more common forms, the student is referred to the standard text-books of Mechanism or to the other articles of this series.

Cams that are intented for high speeds should be so constructed as to give a smooth motion to a follower, i. e., a motion free from jerks due to sudden starting and stopping. The principle on which they are designed is, that as the cam rotates the follower shall start gradually from rest, increase to a maximum velocity at the middle of its stroke and then gradu-

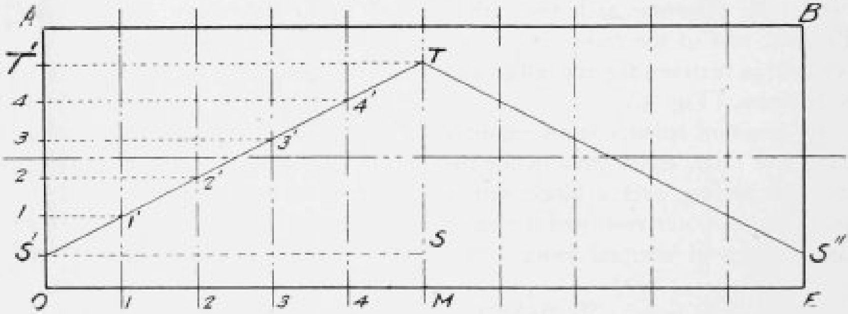


Fig. 1

ally come to rest again. The motion is uniformly accelerated during the first half of the stroke and uniformly retarded during the last half of the stroke. The method of laying out the curves for high speed cams will be applied in this article, 1st to a cylindrical cam having a roller follower mounted on an arm which oscillates about a fixed center (Fig. 4). 2nd to a plate cam having a bar follower, which moves so as to remain always parallel to its initial position. Fig. 5.

In uniformly accelerated motion, the distance passed over by a moving point varies as the square of the time it is in motion, i. e., if a point moves one inch the first second it will move four inches in two seconds, nine inches in three seconds, etc. If these values were plotted with reference to a pair of co-ordinate axes the resulting curve would be parabolic. This, therefore, is the form of the curve for a high speed cam.

Suppose we take a sheet of paper *OABE* (Fig. 1) and lay out on it a line constructed as follows: Bisect *OE* at *M* and divide *OM* into any convenient number of parts, say 5. On the perpendicular through *M* lay off any distance as *ST* and divide it into the same number of parts as *OM*. Through the divisions 1, 2, 3, etc., on *OM* erect perpendiculars and through the divisions 1, 2, 3, etc., of *S'T'* draw parallels to *OM*. Then through 1', 2', etc., the intersections of these two sets of lines draw *S'T*. The line *TS"* would be constructed in the same way on the other side of *MT*. Now if the sheet of paper were wrapped around a cylinder (as shown in Fig. 2) whose circumference is equal to *OE*, and the cylinder made to revolve on its axis, a point forced to follow the path *S' TS"* would move up a distance *ST*, while the cylinder was turning half around

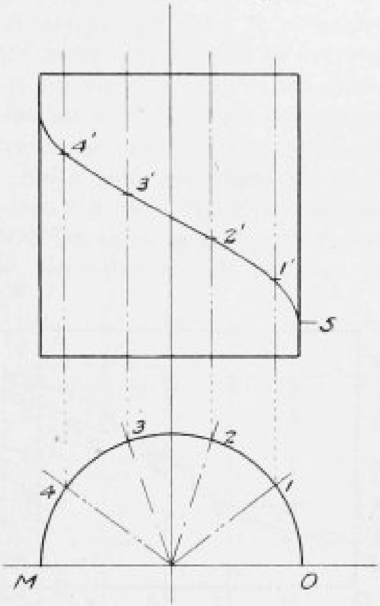


Fig 2

and then down again to where it started as the cylinder completed its revolution. The following point would have the same velocity throughout its motion. It would go from rest to its maximum velocity with a sudden jerk and get another jerk at the top of the cylinder where it turned to come down. Such a motion would be very trying on a machine particularly if the reversals took place rapidly.

Suppose now that the path of the follower on the cylinder, instead of being a straight line wrapped around the cylinder is made a parabolic curve reversing at 3'. Fig. 3. Then if this curve is wrapped around the cylinder as shown in Fig. 4 a follower moving along this path will start gradually from S', increase to a maximum velocity at 3' and then come gradually to rest again at T, while the cylinder revolves thro an angle of 180° From T to S'' while the cylinder revolves the remaining 180° the motion of the follower will be reversed coming to rest again at the original starting point.

The method of laying out this curve is as follows: In Fig. 3, lay off OM equal one half the circumference of the cylinder. Bisect OM at 3, and $S'T'$ at $9b$. Divide $O3$ into any convenient, number of parts say 3. Then divide S' $9b$ into the square of three parts as shown. Erect the perpendiculars at 1, 2, 3, and draw the horizontals through $1b$, $4b$, and $9b$. The intersections 1', 2', 3' will be points on the curve. Now divide $3M$ into three parts and the distance T' $9b$ into the square of three parts and get the intersections 1'', 2'' and complete the curve from 3' to T through these points. The curve TS'' corresponding to the second half of the cylinder's revolution is laid out in the same way. This curve can be found in Fig. 4 by projection, as shown at ST. If two more curves are drawn parallel to this one and at a distance apart equal to the diameter of the following roller, they will represent the sides of a groove which will drive the follower vertically up and down the required distance according to the law of the high speed cam.

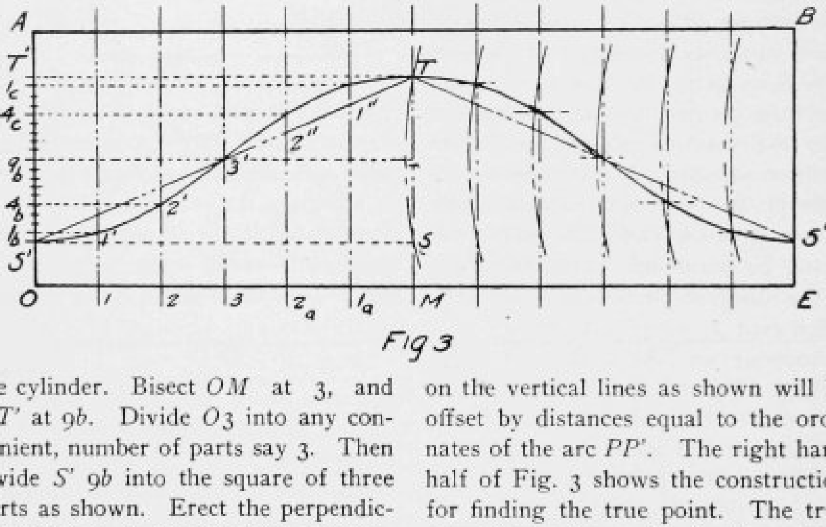


Fig 3

In this example the follower is mounted on an arm which oscillates about Q, therefore the follower, moves up and down on the arc PP' instead of on a vertical line. Then points on the curve TS instead of being found on the vertical lines as shown will be offset by distances equal to the ordinates of the arc PP'. The right hand half of Fig. 3 shows the construction for finding the true point. The true curve is the lower line in the middle of the groove in Fig. 4.

Now consider the plate cam having a bar follower in Fig. 5, O is the center of the base circle of a plate cam which by revolving about O will drive the bar B upwards from A to T with uniformly accelerated and retarded motion while the cam is revolving thro' an angle of 120°, hold it at rest at T while the cam revolves another 120° and then let it fall to its original position as the cam completes its revolution. The motion

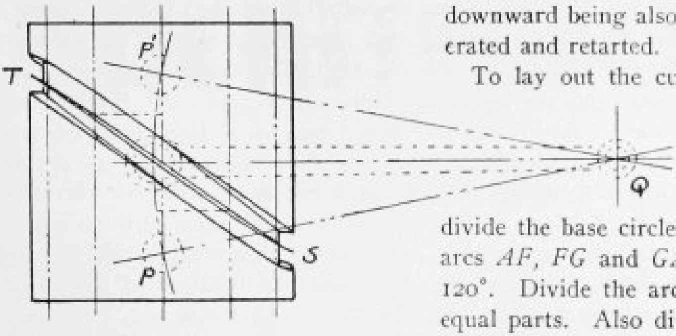


Fig. 4

downward being also uniformly accelerated and retarted.

To lay out the curve of this cam, divide the base circle into three equal arcs *AF*, *FG* and *GA* each equal to 120°. Divide the arc *AF* into two equal parts. Also divide the distance *AT* into two equal parts at 9*a*. Divide

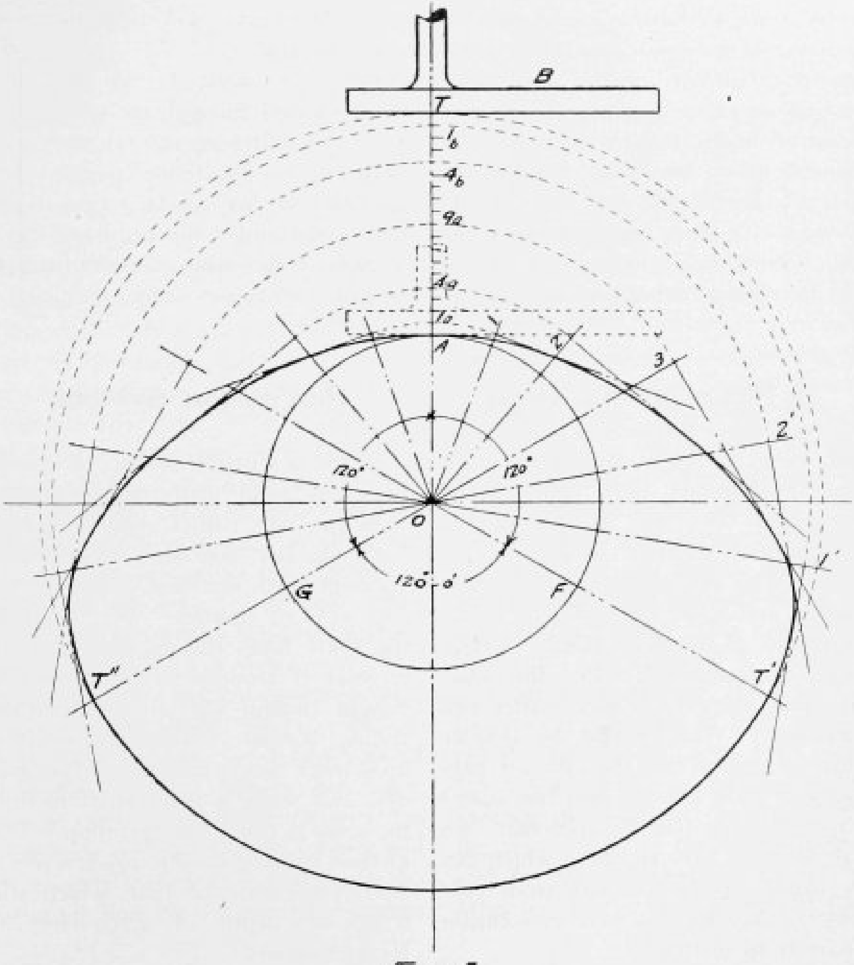


Fig. 5

the first half of the arc *AF* into any convenient number of parts, say three, and draw the radii *O*1, *O*2, *O*3. Lay off the distance *A*9*a* into the square of three parts or nine. With *O* as a center and radii *O*1*a*, *O*4*a*, *O*9*a*, draw arcs cutting the radii to the base circle in the points 1, 2, 3. At these points draw lines making the same angle with the corresponding radius as the bar *B* makes with the original position of the radius *OA*. In this case the angle is constant and equals 90° since we have assumed that the follower is to remain parallel to its initial position, but if the bar were hinged so as to oscillate about some point off at the side of the figure, the point *T* on the bar would move in the arc of a circle and the angle would change with every new position of the cam. Now divide the second half of the arc *AF* into three parts, also divide *T*9*a* into nine parts. With center at *O* lay off *OT'* equal to *OT*, *O*1, equal to *O*1*b*, *O*2' equal to *O*4*b*. Draw perpendiculars to the radii through these points as before. A smooth curve drawn tangent to these perpendiculars will be the required curve of the cam and as the base circle revolves about *O* the bar will move upward from *A* to 9*a* with uniformly accelerated motion and then from 9*a* to *T* with uniformly retarded motion.

For the period of rest the curve is simply the arc of a circle with radius *OT*. The curve *AT''* is laid out exactly like *AT'*.

It will be noticed that the curve does not pass through the points 1, 2, 3, 2', etc., but tangent to the lines drawn through those points. The reasons for this can be found in the text-books under the ordinary forms of cams of this class or under the subject of rolling and sliding contact.

In Place of the Atom.

If we must discard the atom what are we to accept in its place? Two new conceptions have been found necessary—the "ion" as the unit of matter, the "electron" as the unit of force. The new chemistry holds that matter and force are different manifestations of the same thing. Inertia is the characteristic; indeed, the indispensable, property of both matter and electricity. What would be simpler than to assume that the ultimate particles of each are one and the same? Prof. Fleming has declared that "we can no more have anything which can be called electricity apart from corpuscles than we can have momentum apart from matter."

Percussion System.

In the percussion system of mining the great boring instrument or trepan, rises and falls with a regular motion, revolving as it does on a vertical axis. Its huge teeth tear and grind the soil and rock to powder. The water in the shaft turns this to pulp and the mixture is brought to the surface in a huge caisson with an automatically sliding bottom. When the shaft is lined with steel tubing, it is pumped dry, and when a relief shaft is sunk the mine is ready for operation. This method is being used to reach a newly discovered seam of coal, which was struck at a depth of 1,190 feet in Kent, England.

ARCHITECTURAL.

Cost of Operating Buildings.

EXPRESSING the cost of operating buildings in terms of the rentable floor space is unusual, certainly so far as most of the published data on the subject are concerned. It will therefore be of interest to record the results of some investigations recently made of a number of New York buildings, particularly as figures on this basis are valuable as indicating possibilities of comparison between buildings of the same as well as of different classes. The data were compiled from actual running expenses by Mr. J. D. Wilson, treasurer and mechanical engineer of the American Elevator Company, of New York, and cover both office and loft buildings.

Of the office buildings selected one is located on Broadway and is fifteen stories in height, having about 56,900 square feet of rentable area, including space in basement and attic. The building has its own lighting, heating and elevator plant, the latter of the hydraulic type, and the operating cost, on the basis of the bills incurred in 1901, was 35 cents per square foot of rentable space. When insurance, water rents and similar charges are included, the cost was 65.1 cents and 70.2 cents including maintenance, indicating that the maintenance charge was something over 7.8 per cent. In the case of a second office building, in what is regarded as the uptown, office-building section, having over 18,500 square feet of renting space, the net operating cost was $1.25 per square foot per annum, but, including taxes, was $1.42. The maintainance charge was 23 cents, or 16.2 per cent., making the total $1.65. This building has electrically operated elevators and pumps and the current is furnished from an adjacent plant. The difference in operating costs in the two buildings is in part due to the difference in size.

In the case of the down-town building, Mr. Wilson made a subdivision of the costs, which, though largely based on estimates, is interesting. The cost of the lighting service alone was obtained in the following manner: From a twenty-hour test during the winter, the output of the electric plant was found to be 576.9 kilowatt-hours, the average load being 258.4 amperes at 112 volts. By allowing 8 pounds of coal per kilowatt-hour, the coal consumption chargeable to light was, as readily calculated, 2.31 tons. This amount, however, he assumed as the average daily amount burned during the six months of the winter season, and for the consumption during the other half of the year, when less lighting is required, made a reduction of 40 per cent., leaving the figure 1.39 tons. These two amounts into a half year in each case, with coal at $2.77 per ton, the price then current, gave the total coal bill for lighting service as $1,-872.46. It happened that the amount of coal represented by this cost was about one-third of the total amount burned and accordingly one-third of the engineering charges of the building, such as labor, water, taxes, insurance and supplies, or $1,579.84, was added. To this was then included the cost of work done in electric equipment and maintenance, $473.42, and the cost of lamp renewals in one year $80, making the total cost of lighting $4,005.72. There were 1,667 16-candle-power equivalents in the building, so that the cost per 16-candle-power equivalent was $2.41, or, if interest at 6 per cent. were included, $2.54. One 16-candle-power equivalent was furnished for every 34 square feet of rentable floor space, but if some 200 lamps used for public lighting were excluded, there was one equivalent for every 38.5 square feet. The difference between the total coal consumed in one year, 1,596.6 tons, and the amount used for lighting, was charged to pumping, namely, 920.4 tons. Of this, 25 per cent. was regarded as required for miscellaneous pumping, leaving 691.3 tons for the elevators. There are four passenger elevators which travel at a speed of 450 feet per minute and were found to make an average of 304 round trips per day, carrying 4,500 passengers. They approximated on this basis 76.4 miles per day, or 22,900 car-miles per year of 300 days, allowing for days of light operation, such as Sundays and holidays. The coal cost, at $2.77 per ton, was $1,914.94, or 83.5 cents per car mile. To this were added $3,159.-68, the remainder of the engineering account; $3,276, the wages of the elevator operators and starters; and $272.20, the cost of elevator repairs; that is, a total of $8,622.82, or $3.77 per car mile on the basis of 300 days, or $3.09 on the basis of 365 days.

The loft building, though furnishing power to the tenants, has a cost of operation that is very low in comparison with the office building, indicating the increased cost ratio of the conveniences of the modern office structure. One loft building, having 88,410 square feet of rentable space, cost for operation, 13.4 cents per square foot per annum, or 14.4 cents if maintenance charges were included. Another having 132,938 square feet of renting area and 2,027,000 cubic feet of contents, cost for operation 16.9 cents, or, including maintenance, 17.8 cents. In this buildng live steam is supplied for heating and feed water is introduced into the boilers without heating. Here the coal, oil, supplies and repairs cost $3,173; taxes, insurance and water, etc., $16,578; and labor, $3,963. A third loft building having 84,796 square feet of floor area, of which 75,198 is rentable, and 1,526,000 cubic feet of contents, cost 17.9 cents per square foot, including repairs. No electric light was furnished, nor high speed elevator service, and there was no janitor. The coal, oil and repair account amounted to $2,261; insurance, taxes and water to $9,132; and labor to $2,040. A fourth loft building, of a high class, having electric light, elevator and steam service, showed a cost of 19.5 cents per square foot per annum, including plant repairs, for the 71,913 square feet renting space available. There were 492 16-candle-power equivalents in the building which an analysis indicated cost $3.33 per equivalent per annum. The plant, which was run normally 10 hours daily, consisted of two 80-horse-power boilers, two elevator pumps and one 30-kilowatt electric unit.—"*The Engineering Record.*"

Relation of Window-Area to Floor Space.

A SOMEWHAT informal, though careful, effort has been made in the halls of Cornell University to determine a general statement of the relative proportion between window-openings and their position, and the floor-area and the depth of the rooms to be lighted. The data were intended to apply to the problem of securing an adequate supply of natural light in the lecture-rooms on all ordinary days between 8 a. m. and 5 p. m., under the climatic conditions which prevail in Ithaca, N. Y.

Information was secured which was based on actual experience in six buildings on the Cornell Campus, and referred to rooms lighted from one side only. From the statements submitted by the professors in charge of the work in the several buildings the following data have been compiled regarding sixteen rooms adequately lighted, and nine rooms in which the light is "nearly sufficient."

Number of rooms.	Total area of the Floors. feet.	Windows. feet.	Ratio.
Sufficient 16..	10,466	2,000	1,000:191
Nearly so 9..	5,392	799	1,000:146

Av'ge Depth of room.	Av'ge Height of window-tops.	Ratio.
22 ft. 1 in.	11 ft. 9 in.	1,000:538
20 ft. 6 in.	10 ft. 2 in.	1,000:495

All these rooms are alike in having unobstructed light; no building stands before the windows.

A peculiar relation which should be observed is that the well-lighted rooms have an average of 654 square feet of floor-area and 22 feet 1 inch deep, while those whose light is "nearly sufficient" are smaller and shallower, being 599 square feet area and 20 feet 6 inches deep.

One explanation of this unexpected result is found in the figures relative to the positions of the windows. In the well-lighted rooms the window-tops average 11 feet 9 inches above the floor and 1 foot 6 inches below the ceiling; in the other rooms they are one foot 7 inches nearer the floor and 11 inches farther from the ceilings.

The conclusions to which this local experience leads are these:

(1) There should be at least 150 feet of window-space in each 1,000 square feet of floor space in rooms which, in use and location, are simiiar to those here described, and are lighted only from one side.

Therefore an office 15x25 should have at least 56 square feet of window-space and a class-room 30x40 should have at least 180 square feet of unobstructed lighting surface.

(2) The proportion between the height of the window-tops and the depth of the room lighted should be at least 500 to 1,000, or, in other words, the distance from the floor to the window-tops should be one-half the depth of the room to be lighted.

These figures support the old principle that "top-light" is the best; the nearer the window-tops come to the ceiling the more efficient will be the lighting to be secured from a given surface. Care should be taken that overhanging lintels be not allowed to obstruct the light.—*"Keith's Magazine."*

Beam is Powerful.

WEDNESDAY afternoon at the new Lyric theater occurred a test of a comparatively new style of beam which has been placed in the theater for the support of the balcony, the test being witnessed by a large number of interested architects and builders who were attracted by the an-announcement that the supreme test would be administered to the beam.

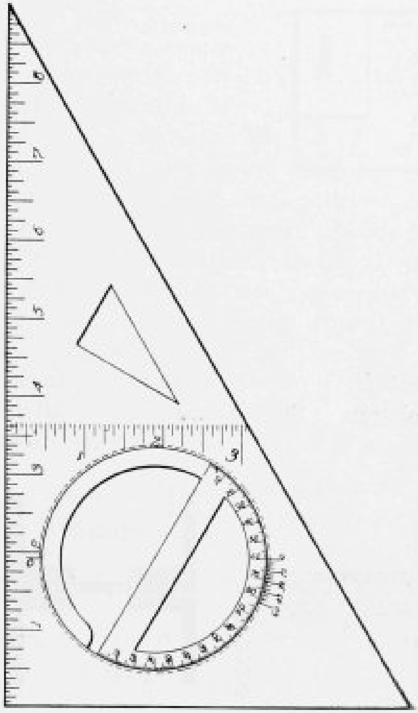
The feature of the beam is that instead of being constructed of steel, as is usually the case, it is constructed almost wholly of concrete of an extra fine quality. In addition to the concrete and for the purpose of bracing it, a number of steel rods 1½ inches in diameter were scattered through the beam; some the entire length, some four-fifths the length and some only through the central portion. The beam is 55 feet long and supports the entire balcony of the theater without a column on the center to obstruct the sight of the people who may happen to sit at the rear of the first floor. It is 5 feet deep and 12 inches in width and by means of bolts driven into the concrete when the material was soft, the wooden flooring and girders are held in their proper positions.

The test was a pronounced success in every way and proved the practicability of the system of concrete construction. The contract under which the beam was constructed called for a test of seventy-five tons on the entire length of the beam and by means of a chain swing and a heavy wooden platform, a weight of over forty-four tons was swung on a space in the center seven feet in length. With this enormous weight, the deflection of the beam, calculated by minute measurements, was but nineteen-thirty-seconds of an inch, a deflection of over an inch and a half being necessary before the outward condition would give evidence of the strain. The beam rests on its own foundation and is supported at each end by its own columns, making its construction such that the entire building could be removed from about it and the beam would still remain standing. The weight placed on it yesterday was in the form of pigs of iron and constituted a load equal to 2,544 pounds per lineal foot. The weight of the largest locomotive used on the railroads running into Cleveland is but 2,500 pounds per lineal foot, affording a comparison by which to estimate the great strain the beam was under.

The building of concrete beams of the character of that just completed has been almost unknown and the one in the Lyric theater is, so far as known, the largest in the United States. The architects who were present and the members of the board of management of the theater expressed themselves as very well pleased with the test. The architect of the theater is Frederick William Striebinger.

A Very Convenient Triangle.

ENCLOSED find sketch of a celluloid triangle, which might interest the readers of The Draftsman and that which any draftsman might construct.



The inches are graduated on the lower side, and by moving the tee square up or down lines may be scaled and drawn at the same time, thus avoiding so much erasing as we are accustomed to do.

Vertical lines up to three inches apart can be drawn very accurate.

The protractor, though very small, is quite useful. This part can be purchased at any dealer of draftsmen's supplies, the edge leveled and sprung into place.

If others will adopt this plan, they will find it very useful.

E. A. Chamberlin.

The Greatest Ocean Depth.

The deepest spots in the Mediterranean are said to be only 14,000 feet, while the bottom of the Atlantic Ocean is said to have but few places deeper than 21,000 feet. Altogether there are forty-three spots of greater depth known, of which twenty-four occur in the Pacific, fifteen in the Atlantic, three in the Indian Ocean and one in the South Polar Sea. The deepest thus far known spot in the ocean is that known as Aldrick Death, to the east of the Kermadec Isles, in the southern part of the Pacific Ocean, to the northeast of New Zealand, with a depth of 32,058 feet.

STRUCTURAL.

Notes on Shop Inspection.

C. J. Tilden, C. E.

IN structural steel shops the inspector is often called on to suggest remedies or alterations from the original working drawings. Of course no deviation from the drawing should be allowed unless absolutely necessary, but occasions sometimes arise when when serious delay would result from too strict adherence to the drawing.

Suppose, for example, a shop is building a number of plate and angle columns having the cross-section shown in Figure 1. The material for

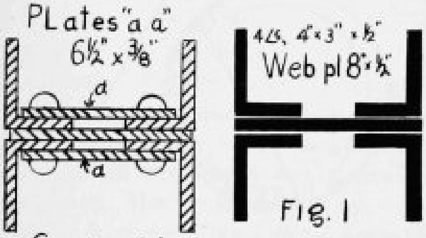


Fig. 1

Section A A.

these has been ordered from the mill, and is supposedly sheared to the length required. When the columns are riveted up it may happen that one of the web plates is short, so that the top of the column appears like Figure 2. To wait for a new plate to come from the mill would be out of the question, as it might hold up the erecting gang in the field indefinitely. It would be possible, perhaps, to take a new plate out of stock on hand at the shop; but to cut out all the web rivets and replace the plate would be a tedious and expensive task. What, then, is the quickest and best way out of the difficulty?

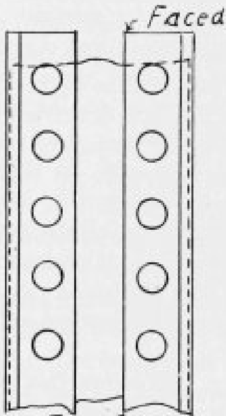


Fig 2

If a cap plate is to be used (as is nearly always the case) between this length of column and the length next above, the top of the column may be planed down until the full section appears on the faced end, and the cap plate made correspondingly thick to bring the column up to the required length. This, of course, generally precludes the use of a single rolled steel plate for a cap, as the thickness required would be too great. To use two or more thinner plates would be bad practice, as it would be almost impossible, with sheared plates, at least, to get them suffciently even to insure good bearing surfaces between adjacent plates. If this expedient is resorted to, therefore, the inspector should insist on a cast cap plate, accurately planed to the required thickness.

If the web is so short that planing down the end of the column would bring the faced end too near the web rivets, or if, for any reason, it is essential to keep the faced length of the column unchanged, a different solution of the problem must be sought. Instead of planing the column down until the full section is secured, it may be built up, as shown in Figure 3, un-

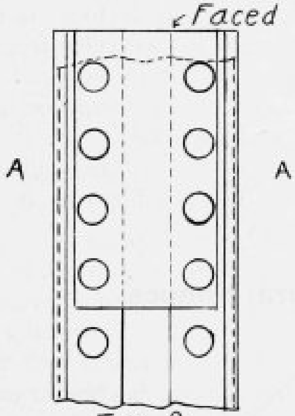


Fig 3

til the section lost in the web is made up by the two outside plates, *AA* riveted to the web of the column outside the flange angles. The problem for the inspector then becomes one of design, i. e., to determine the proper size of these reinforce plates and the number of rivets required to hold them, and to solve it exactly he should know just what unit stresses have been assumed by the designing engineer in proportioning the columns. An exact solution, however, is of little value in a case like this; an approximate solution, quickly reached, is what is wanted, with one proviso, viz., that the necessary assumptions shall be so made that any error in result will be on the safe side. The designer of the column probably used 12,000 pounds or 16,000 pounds "reduced," as his allowable compressive stress per square inch in computing the columns sections, i. e., say, 12,000 pounds per square inch for short columns, reducing this allowable stress as the unsupported length of column increases in accordance with some approved column formula. If, then, the inspector uses 10,000 pounds per square inch as the allowable unit stress, he can be fairly sure of being well within the limits of safety. If the web plate is 8 inches by ½ inch, that is, has a sectional area of 4 square inches, or, at the assumed unit stress, is capable of supporting 40,000 pounds safely, and it is to be reinforced where the deficient by two plates 6½ inches wide, each plate should have an area of 2 square inches. A plate 6½ by 5-16 inch has a sectional area of 2.03 square inches, just sufficient to fulfill the requirements, but to be surely on the safe side it is better to use ⅜-inch metal; two plates 6½ inches by ⅜ inch have an area equal to 2 by 2.44= 4.88 square inches. Since these two plates virtually place the web of the column at the point where it is defective, they must together carry the entire load assigned to the web, or 40,000 pounds, so each plate must be capable of supporting safely 20,000 pounds. If the rivets are ¾ inch in diameter, each rivet will carry 3,300 pounds in single shear (assuming 7,500 pounds per square inch as a safe shearing stress for rivet steel); consequently, for 20,000 pounds load, seven rivets will be required. For the sake of symmetry, eight are used, and the appearance of the reinforced column will be as in Figure 3.

The reinforce plates should, if possible, be riveted on before the column is "faced" or planed for bearing. Generally, however, the defect in the web plate would not be noticed until after the column had been faced; the reinforce plates must then be sheared ¼ inch or ⅜ inch long, and the column again put through the machine to bring the entire section to an even bearing.—*"Ryerson's Monthly."*

New Industry Begun.

The manufacture of steel mine ventilators is a new departure at the Monongahela Manufacturing Company's plant. The device was invented and patented by Charles Kuderer, who is associated with the company. It is the result of years of experience with mine ventilators and is based on the most approved and recent scientific investigation.

Unlike the old ventilators of wood, it is constructed entirely of steel and its general design embraces the best practical principles.

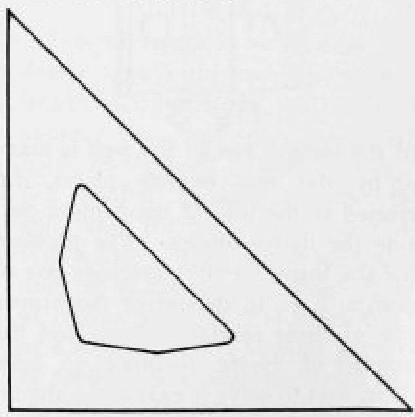
The ventilators will be made on the duplicate interchangeable part system and will be shipped to all parts of the world where mine ventilators are used. Leading mining companies are welcoming Mr. Kuderer's invention.

The company will manufacture the ventilators in sizes from 4 to 25 feet in diameter. The 20-foot machines will generate 400,000 cubic feet of air per minute at 3 7-10 inches of water gauge. The steel construction insures safety at high rotative speeds ranging from 10 to 1,000 revolutions per minute. The new plant is at Monongahela City, Pa.

A Triangle for Structural Shapes.

Though not new, it is a good idea to cut one's triangle as shown to give the angle of the base of T-rails and rolled shapes such as channels and I beams. The angle of the flange of a rail with its bottom is 13°, but the taper on the flanges of channels and I beams is 2 inches in one foot. Lay off a horizontal line with the tee-square, then measure 12 inches along it from a point and then vertically 1 inch, completing the triangle with a sloping line.

Cut out one side of the center oppening to fit this line and the other side



for 13°

ILLUSTRATING.

The Art and Invention of Letter Design—Its Beginning and its Uses.

By Charles C. Riester.

THE art of invention which perpetuates the history and achievements of all the arts and sciences has been contested unceasingly. This, however, should not be surprising when we consider that the inventive instinct of the human race is everlastingly striving to bring before the public new ideas, new designs and inventions which marks the progress of universal ingenuity. One of the greatest benevolences is the invention and discovery of printing, that is, to make designs in a movable body so as to make each body a letter.

For four centuries the controversy has raged without giving up its mysterious origin. Volumes have been written, lives have been spent, fortunes have been wasted, communities have been stirred, a literature has been developed, to find an answer to this mysterious question: "When, where and by whom was found out this masterful art of printing books?" And yet the world today is little nearer a finite answer to the question of the greatest and most cultivating discoveries, namely, the invention of printing books. Indeed, the dust of battles has added to, rather than diminished, the mysterious clouds which envelope the problem, and we are tempted to seek refuge in an agnosticism which almost refuses to believe that printing ever had an inventor. But, meanwhile, it is possible to avail ourselves of whatever evidence exists as to the nature of the letters, and as to the methods by which those letters were produced, and possibly to arrive at some conclusion respecting the earliest practices of the art.

However, there is a legend of the invention of this art, as far back as the beginning of the 14th century, of a man, Laurentius Joannes, surnamed Aeditus or Custor. To this man should revert the wrested honor of the invention of the art which has been wrongfully enjoyed by others. A just judgment should give to him before all others the laurel which he has deserved as the most successful.

While strolling in the woods near the city, as a citizen who enjoyed ease and time, it happened that he undertook as an experiment to fashion the bark of a beech tree in the form of letters.

The letters so made, he impressed the reverse way consecutively upon a leaf of paper in little lines of one kind and another.

He had succeeded so well in this that he aspired to greater things, as became a man of cultivated and enlarged capacities. With the aid of his son-in-law, Thomas Pieterzoon, who afterwards, by the addition of letters cut into a block, procured rough sheets of print with letters black and solid. Sometimes very heavy embellishments

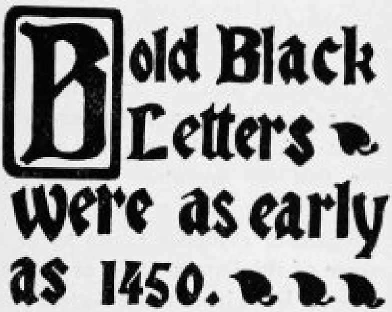


FIG. 1

were cut around the print; sometimes a blank space was left for the initial letter, which marked the beginning of each page.

The Germans used a Bold Black in 1450. The character itself was a rude old Gothic, (Fig. 1) similar to that now known as old English, or black mixed with a design called *secretary*, to imitate the hand writing of the ancients. The letters were so close that the matter was not easily read. Blanks were left for the titles, initial letters and the various ornaments to be supplied by expert illuminators or artists whose calling did not long survive the masterful improvements. The ornaments were exquisitely fine, and often variegated with beautiful colors, even with gold and silver. In Fig. 2 you will see some ornaments which were greatly used with this letter.

The margins likewise were charged

FIG. 2

with ancient peculiarities. The pages were either large or small folios, but sometimes quartos. The leaves were without titles, directions, words, divisions and paragraphs.

The Italian Scribes of the 15th century were famous for their beautiful manuscripts, written in a hand en-

FIG. 3

tirely different from the Gothic of the Germans.

German artists afterwards changed the Gothic letter into that of the Roman. In 1470, Roman letters were used in Italy, from thence the Roman letter was used throughout Europe. In Fig. 3 you will see the Roman letter, both as where used in initial lettering, and the regular script.

The work and toil of cutting these letters involved in the first undertaking was very painful to trace all of the characters and figures, the reversed way, so as when imprinted on the sheet made it readable. This was scarcely less tedious than copying the required number by the deft pen of a scribe, who were few in number at that time, although at the present time

FIG. 4

there are considerable able designers and sketch artists who make the selfsame designs as were then in vogue.

The Roman letter was the first style used in France, in the year 1470. It was a handsome round style, with a slight suggestion of Gothic in some

FIG. 5

of the letters. Gehring, a German, and his associates designed from the best available models and the entire alphabet was without initials. The authority was Chevilliers, on initial letters regarding the capital, fot which blank spaces were left to be filled in by hand.

In Fig. 4 you will see the letter I set into a plate of embellishments, or back ground which is made heavy enough to correspond with the bold face of the I. This letter was used in all the works of Sorbonne press, but when Gehring left the Sarbonne and established himself at Soleil d'Or, in 1473, he made use of the Gothic letter, which is illustrated in Fig. 5.

Fig. 6

These specimens in initial and page ornaments and embellishments, which when put in with neat designs, leaves, acorns, grapes, roses can be worked in to good advantage as will be seen in Fig. 6.

These designs can also be used in architectural work, such as wall paneling, ceiling decorations, etc., which will be illustrated in the next number of this magazine.

Five Toasts.

The Russian—"Here's to the stars and bars of Russia that were never pulled down."

The Turk—"Here's to the rulers of Turkey, whose wings were never clipped."

The Frenchman—"Here's to the cock of France, whose feathers were never picked."

The American—"Here's to the stars and stripes of the United States of America, never trailed in defeat."

The Englishman—"Here's to the rampin', roarin' lion of Great Britain, that tore down the stars and bars of Russia, clipped the wings of Turkey, picked the feathers off the cock of France, and ran like h—l from the stars and stripes of the United States of America."

It has been said that a man with brains does not have to work. A more correct statement would be that anybody who has original ideas of benefit to humanity can always find a market for them. The trouble with most people is that they are running in a groove. There is a wide and rich field open to anybody who will step out of the groove and do something "different."

Originality in Drawing.

By D. Eldred Wood.

LET me say to all students of drawing, either freehand or mechanical, illustrating or delineation of whatever sort, sculpture or art of any kind, BE ORIGINAL. Through the avenue of originality is the only gateway to your great and permanent success in your chosen field. Do not be a cheap imitation of your teacher or instructor, no matter who or how great he may be. Always be yourself and stamp your own individuality in every piece of work you turn out.

Especially is this for the freehand pen and ink illustrator, the commercial designer, the cartoonist; for while all articles who aspire to anything great should cultivate originality, still this particular class should consider it well, for it shows more plainly in their work than elsewhere.

What is called originality by many people and which passes as such and sometimes places a so-called artist in a good position, is not originality at all, but purely adaptation. Take for instance, a designer of letterheads, envelopes, or other commercial work of like nature. A very casual glance at the work turned out by any one artist of this class, will reveal a very marked similarity in his work. He has a fondness, so to speak, for certain scrolls, certain technique, or certain lettering, which he almost invariably follows. It is frequently the case that this little "hobby" is not all his own, but he has copied, in other words "borrowed" the idea from some one else—perhaps because it is easy to make, or fills up the space all right. He has fallen into a rut, an easy way of making things and doing his work, and so long as it seems to please his customers, he is satisfied.

Such a person is not an artist in a true sense of the word, he is simply a copyist, an imitator, the cheapest kind of a pretention for something which he is not and never can be as long as he continues such work.

On the other hand, how much greater would be his success, if he would put something new into every piece of work, if he would strive to out-do his last efforts, and always make his last work a little better than his previous one. There is a multiple stimulation in such work, and it affects the customer, who always wants something "out of the ordinary," and is willing to pay for it. This makes work for the artist, the engraver, the printer; all lines and occupations are benefited by the efforts of the artist to do his best.

It has been said that no man is an artist who does not feel, after completing one piece of work, that it can be improved in some one or more places. In other words if he cannot find fault with his own work, as mercilessly as he does some one else's work, he is not a true artist. (If this be so, he is, to say the least, very false and untrue to himself if he does not, when the opportunity is presented, endeavor at least to better his own efforts, and develop his own ability and originality.)

This same line of argument can be applied with the same measure to all other branches of art work. There are too many so-called cartoonists in the country, who do nothing more than copy from the work of others. They make a selection of an idea from some other person's work, and by changing it a little here, a little there, they adapt it to their own needs and thus it passes inspection. But the artist, like the school-boy who uses "ponies" in his examination, has cheated himself and not his teacher or the public. He believes he has passed examination and prides himself on the fact that he has deceived others into the belief as to his ability to do original work. But what happens when he is called upon for a "little out of the ordinary?" What does the artist (?) do then? Usually he copies again, and endeavors to palm off somebody else's ideas, perhaps not half as good as his own would be, and he has lost another opportunity to step up into the field of true eminence.

All great artists are truly original, and he who is original in his work cannot fail to become great and famous if he perseveres. Such men as Gibson, Helleau, Davenport, McCutcheon, Opper, Abbey, and many others are original in their work, and in their originality lies their greatness. They are not afraid to step out into the darkness, to originate and develop their own ideas, to stamp their own individuality into every piece of work they do.

If your instructor is not prescribing work for you which will develop and bring out your own ideas, your originality in this line, he is not doing his duty by you, and you should see that he does, or else obtain instruction from some other source.

Of the schools teaching all branches of drawing and illustrating, and which make a specialty of training the young artist to do original work, the Acme School of Drawing is perhaps the best. It is one of their requirements, and justly so, that a student shall be trained and his ability developed in this line.

Strive then to make original drawings. Do not be content to be a mere copyist, but put something of your own into all your work. You remember the artist's secret, as told by Olive Schreiner in Dreams. He took his own life's blood to make his colorings, he put his heart and soul into his work, and he had a style, individuality, and originality of his own. You can be as great as he, or anyone, if you will be original.

HOME STUDY.

Elementary Mechanics.

BY N. C. HURST.

PART II.

LET us now consider Pulleys or Blocks which are in every day use in hoisting weights, elevators, and moving heavy weights. Let (w) be the weight lifted or the resistance and (p) the force applied or the full and (P) the force necessary to sustain the stationary pulley blocks or in other words to resist the combined action of (w) and (p).

Fig. 4 represents the single stationary block, i. e., a single stationary pulley which can be used for obtaining advantage of position of pulling power only. (a) is the pulley or sheave of radius (r) and rotates about the axle or axis (o) and (w), (P), and (p) are the forces acting. To find the relation between (w) and (p) consider the pulley as a revolving lever, revolving about (o) as a center or fulcrum, then we have $pr=wr$ (pr being the same as $p\times r$) and since the (rs) are equal ($p=w$) or $\Sigma m=o$ since $pr-wr=o$. To find the value of (P) we take the algebraic sum of the vertical forces or parallel forces for all vertical forces are parallel practically considered. Doing this we have ($P=W+p$) and converting this equation into the form Σ vert. forces $=$ o we have ($P-W-p=o$) or (P) equals the sum of (W) and (p).

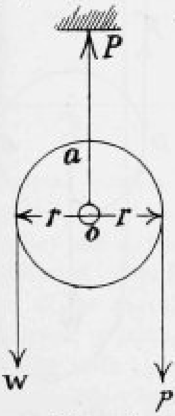


Fig. 4.

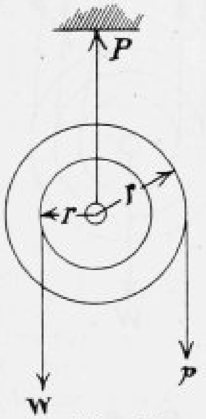


Fig. 5.

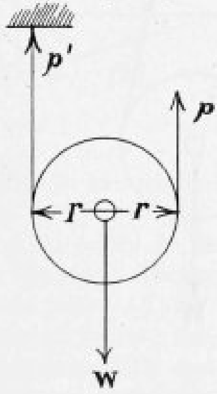


Fig 6.

Fig. 5 is a special case of Fig. 4 where the pulleys are different in size or radius but are fastened together on the same axis and revolve together and are really two drums in that the ropes are separate and must wind about their separate pulleys or drums. Applying Σ m=o to this case we have $pr' - Wr = o$ or $p = \frac{Wr}{r'}$ since we can consider this as a revolving lever as above but one with arms of different lengths.

Fig. (6) represents what is known as the single movable block i. e. the block moves with the weight or resistance (W). Considering this pulley as a lever with equal arm we find that (p′) and (p) are equal to each other or each ply of rope carries half of the load or resistance or $p = \frac{W}{2}$ [4. Thus we find that the movable pulley requires one-half the force. Now for a moment let us see what relation exists between the rates of travel or velocities of (W) and (p). Let (h) be the distance moved by (w) and (l) the distance moved by (p) or some point on the rope while (w) travels the distance (h). Now from the definition of work and equilibrium (w h) is the work done to move (w) through the distance (h) and (p l) is the work done by (p) in moving through the distance (l) and since Σ work=o $pl - wh = o$ or $pl = wh$ 5. Now since equ. (4) tells us that (p) is one-half as great as (w) equ. (5) says that (l) must be twice as great a (h) i. e. substituting the value of (p) from equ. (4) in equ. (5) we have $\frac{wl}{2} = h$ or

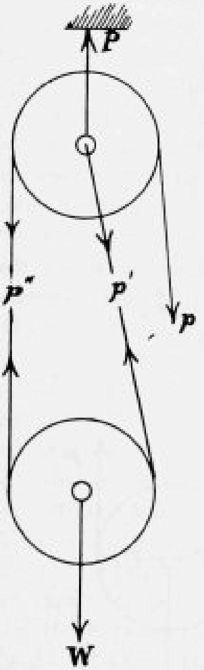


Fig. 7.

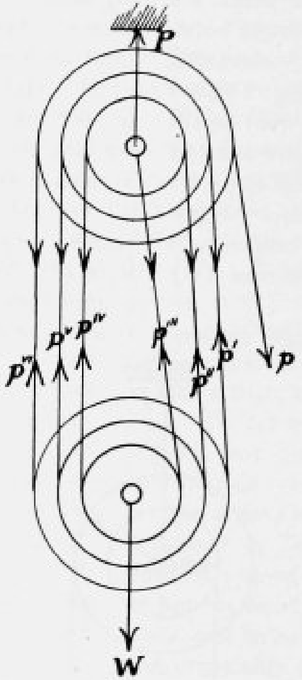


Fig. 8.

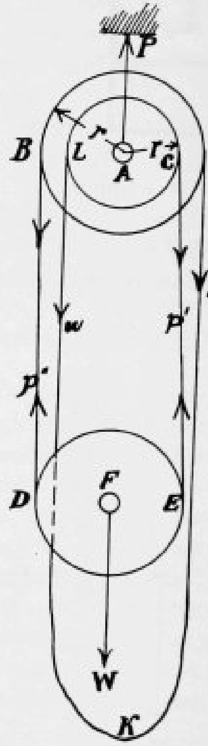


Fig. 9.

$\frac{l}{2}=h$ or $l=2h$. In the case of Fig. (5) the relation between (l) and (h) is proportional to the radii of the drums or inversely proportional to (w) and (p) as will be found upon investigation.

With an insight into the single fixed and movable blocks we will now combine them and find that we will have the ordinary set of blocks or tackle as shown by Fig. (7). This is nothing more than Fig. (6) with a fixed block to change the direction of (p) and therefore all that applies to the single movable pulley applies to this case. We will find that $p=p''$ and $p'=p''$ and that $p'+p''=w$ and that $P=w+p$ or $P=p+p'+p''$ or since $p—p'$ and p'' are all equal $P=3$ p. In finding the value of (P) we deal entirely with the fixed pulley and so the forces p' and p'' act downward instead of upward as in the case of the movable pulley. This is analagous to taking hold of one end of a string with one hand the other end with the other hand and pulling on the string,—the left hand pull is opposite to the right hand pull. Since $w=p'+p''$ and $p'=p$ we have $p=$ which tells us that the ratio of the load or resistance (w) to the pulling force (p) is equal to the number of plies of rope that carry the load (w) which in this particular case is (2)—$(p'+p'')$.

In Fig. (8) we have a tackle with three fixed pulleys and three movable pulleys, the inner end of the rope being attached to the fixed block. Here there are six (6) plies of rope carrying (w) therefore $p=\frac{w}{6}$ $P=7$ p or $P=w+p$. Applying the condition $w\ h=p\ l$ $l=6\ h$ which tells us that if (p) moves six times faster than (w), (p) is one-sixth as great as (w). If (w) and (p) are reversed in position the value of (w) would decrease in proportion to its increased travel and (p) would increase in proportion to its decrease in travel or the whole arrangement would be reversed. This reversed tackle is widely used in elevator installations where great range of travel and light loads are used, such as the passenger elevators in the modern high office building.

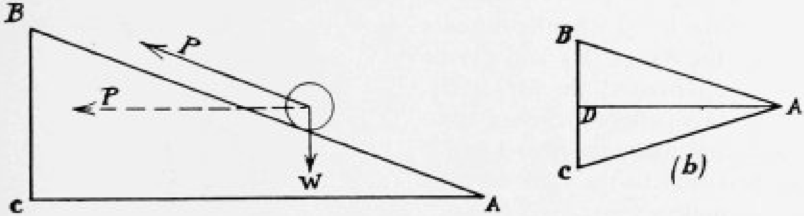


Fig. 10.

The differential pulley or block is illustrated in Fig. (9). This consists of one movable pulley (F) to which the load is attached and two fixed pulleys of different sizes (B) and (C) joined together and revolving about the axle (H). The chain passes over the blocks as shown, the fixed pulleys being sprocketed to prevent the chain slipping. If the chain is run as indicated by the arrows it is evident that the ply (C E) will travel downward while (B D) will travel upward and at a greater rate than (C E) travels downward since the pulley (B) is larger than the pulley (C). Half this difference carries up the movable block and this lifts the load. Thus the less the difference between the size of pulleys (B and C) the greater load can be lifted with a given force exerted on the fly (H K) which is used in lifting. The analysis of this block is as follows: (Σ vert. forces) for the lower block gives $p'+p''=w$ or $p'+p''-w=o$ ($p'+p''$ being equal to each other as in the case of Fig. (5). For the upper pulley we have $P-p-p'-p''-w=o$ (w) being the weight of chain in (L K) $p-p'+p''$ are all equal to each other as in previous cases. Considering the movements about (A) of the upper pulleys we have $p\ r+p'\ r'-p''\ r-w\ r'=o$ or $\Sigma m=o$. Now let (l') be the distance moved by the fly (C E) and (l) be the distance moved by the fly (B D). Since the two pulleys are on a common axle and move together l and l' are proportional to the radii of their respective pulleys.

Since (l') moves downward and (l) upward $l-l'$ is the real upward movement of the chain and the force p''. The pulley (F) is a single movable pulley and we have already found that for such a pulley the force p'' moves twice as fast or as far as the load or resistance (w) therefore $\frac{l-l'}{2}$ is the distance moved by the resistance (w) corresponding to (l) and (l'). Now since p and p'' travel over the same pulley they must travel the same distance or (p) travels the distance (l). Applying now Σ work=o we have $pl=Wl-l'=o$ or $p\ r=\frac{w(r-r')}{2}$ since (l) and (l') are proportional to (r) and (r') the differential pulley may be converted into a differential windlass by substituting drums for the fixed pulleys. This arrangement is seldom used, however, because of the length of rope required. The differential block is widely used for short and heavy lifts and is very convenient to handle.

The Inclined Plane or grade is illustrated in Fig. (10). It is widely used to elevate loads a short distance and in railroad work to get trains over elevations. The relations between (P) and (w) for the arrangement in full lines is $P=w\frac{BC}{AB}$. This expression is derived from the expression Σ work=o $P\overline{\times ab}-W\times\overline{BC}=o$ since force (P) in moving (w) from A to

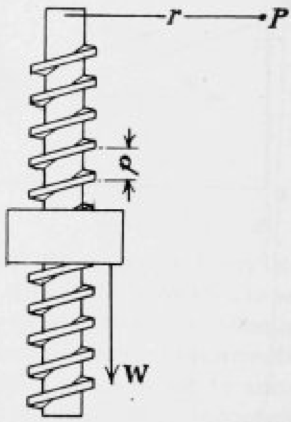


Fig. 11.

B moves through an equal distance, the work it does is $\overline{P\times ab}$ and since (P) in moving this distance elevates (w) a distance equal (b c) the work done on (w) is $w\times\overline{BC}$. For the same dotted lines. The wedge is a movable reason the expression $P=w\frac{BC}{CA}$ apples is the arrangement shown by the inclined plane and is often considered as a double inclined plane as in Fig. 10 (6). The equations are the same as those used for the inclined plane. The revolving cam is a special form of inclined plane as used in the stamp mill and various other machines.

The Screw is an inclined plane wrapped around a cylinder so that the height of the plane is parallel to the axis of the cylinder. If the screw is formed on the inside surface of a hollow cylinder it is called a nut. When the screw is used to overcome a re-

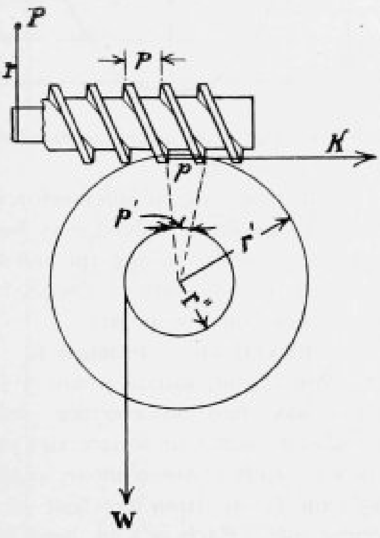


Fig. 12.

sistance either the screw or the nut may be fixed and the other movable. The acting force is generally applied at the end of a lever or wrench or rim of a wheel. Fig. 11 represents a screw and nut operated by a lever of length or radius (r), (p) is the pitch of the screw or height of the inclined plane for one revolution of the screw. (w) is the resistance at the nut and (P) is the force applied at the end of the lever (r). Remembering that while the resistance (w) is raised the distance (p) the force (P) revolves around a complete circle and moves a distance $2\pi r$. Let us now apply the condition Σ work=o and we have $P2\pi r - wp = o$ or $w = \frac{P2\pi r}{p}$ [6.

The worm gear Fig. (12) is a special case of the screw and nut where the nut is replaced by a toothed wheel called a worm wheel: The teeth work in with the thread of the screw or worm and thus as the worm revolves the worm wheel revolves about its axis. (P) is the force acting on the worm at a radius (r) (r') is the pitch radius of the teeth in the worm wheel and (r'') is the radius of the drum on which (w) acts. Let (K) (corresponding to w in equ (6) be the force at the pitch circle and worm threads due to the force (P) then $k = \frac{P2\pi r}{p}$ [7]

Now apply $\Sigma m = o$ to the worm wheel and we have $Kr' = Wr''$ or $K = \frac{wr''}{r'}$ (8). Substituting the value of (K) in equ (7) in equ (8) we have $\frac{P2\pi r}{p} = \frac{Wr''}{r'}$ or $P2\pi r = \frac{Wr'' p}{r'}$ [9]
Now it is evident that the distance (p') moved by W while K moves through the distance (p) is to (p) as r'' is to r' or p' : p :: r'' : r' or $p' = \frac{pr''}{r'}$ (10). Substituting this value of $\frac{pr''}{r'}$ in equ. (9) we have $P\,2\pi r = W\,p'$ or the condition Σ work=o, since $2\pi r$ is the distance moved by (P) while W moves the distance p'.

In all the above mechanical movements the part played by friction has

(This article continued on page 84)

Elementary Course in Mechanical Drawing.

(Continued from January number.)

INTERSECTIONS.

IN practical work, it is necessary to represent all kinds of regular and irregular bodies, which intersect or penetrate each other.

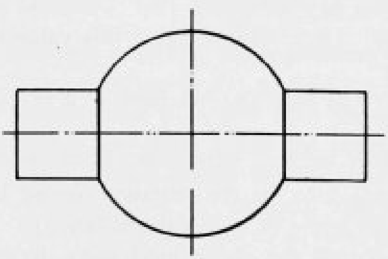
The knowledge required to do this is best obtained by study of the geometric solids, such as the sphere, cylinder, cone, pyramid and prism.

Simple intersections are produced when a body small enough to pass through another, enters one surface and goes out of another.

If the large object is bounded by plane surfaces, the intersections are simply sections of the smaller body, made by the plane surface of the larger.

Simple intersections are given by a cone or cylinder which penetrates a sphere in such a way that its axis passes through the center of the sphere. In this case, the plane of the intersection will be at right angles to the axis of the penetrating body, and the lines in which the cylinder or cone enters and leaves the sphere will be circles.

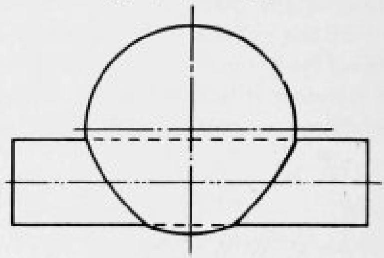
If the axis of the cone or cylinder does not pass through the center of the sphere, the intersections will not



be circles and must be obtained as explained later.

When bodies bounded by plane surfaces intersect, the lines of intersection will be straight and must connect the points in which the edges of each solid penetrate the other solid.

When curved bodies intersect or are intersected, there are *elements* instead of edges, which penetrate the



surfaces and they must be treated as if they were edges.

Then problems in intersections as they are generally solved may be reduced to simply finding the intersections of the elements of the surfaces and connecting the points.

PLATE XII. — Problem 1.

An 1½ in. square prism 3½ in. long has two intersecting prisms which are each 1 in. square and set as shown. Left prism is at an angle of 45°, up ½ in. from the base of the center one. Each is 1 in. long, horizontally from the edge of the vertical prism.

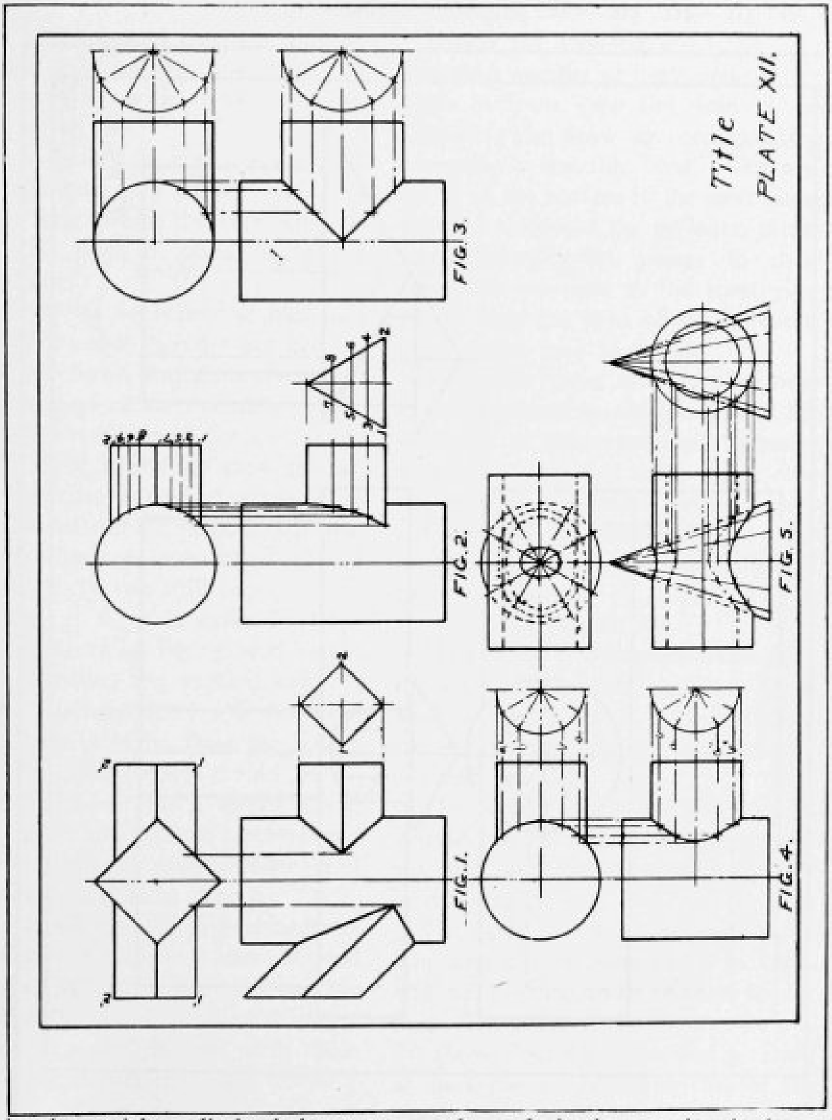
Center lines of Figs. 1 & 4 are 2½ in. from left border line, the base of Fig. 1 being 6½ in. from top border and the center of its top view is 1¾ in. from the top border line also. Right prism at center of vertical one.

About 3 in. from the center of Fig. 1, draw the square and lay off 1 ft—2 ft. in the top view equal to 1—2 on the square. Find the lines showing the intersecting surfaces by projecting down from the top view, where the edges of the side prism intersect the sides of the center prism.

PROBLEM 2.

which is 1 in., the latter being set up 1 in. from the base of the cylinder.

Center line of Fig. 2 is 5½ in. from that of Fig. 1 and the triangle is drawn at the same distance from Fig. 2 as the square is from Fig. 1. Then



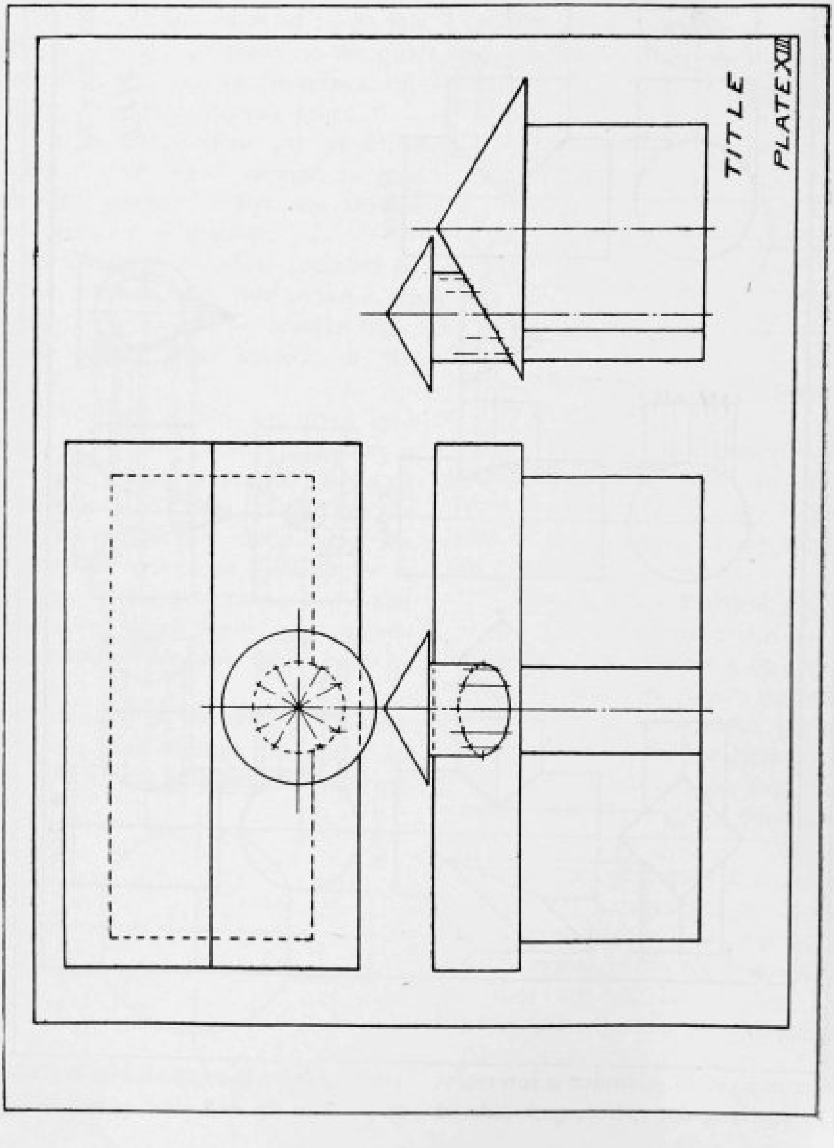
A 2 in.x3½ in. cylinder is intersected by a triangular prism, each side of

1 ft.—2 ft. in the top view is the same as 1—2 in the end view of the triang-

ular prism.

Draw in section lines 3ft.—4ft.= 3—4; 5ft.—6ft.=5—6, etc., locating 3, 5, 7, any place on the triangle.

The lines 3—4, 5—6, etc., are projected from the triangle to the side view and 3ft.—4ft., 5ft.—6ft., etc., are drawn in to cut the circle in the top view. The intersection of these lines with the circle are projected down to the front view and cross the lines from 3—4, 5—6, etc., giving points in the curve which is the intersection of the surfaces.



Problem 3 and 4.

When one cylinder intersects another and both are of the same diameter, the line of intersection is not the same as in the case of two cylinders of different diameters as shown in Fig. 3 & 4.

The center line of Fig. 3 is 3½ ins. from the right border line with its base on a line with those in Figs. 1 & 2.

The cylinders in Fig. 3 are each 2 in. in diameter, the center one being 3½ in. long while the side one extends 2 ins. from the center line of the vertical one.

Half circles representing half end views of the side cylinder are divided equally as shown and elements drawn on the surface of the cylinder. Finding the intersections of these elements and the circle in the top view, project to the front view and find points of intersection of the elements which produce the line of intersection of the surfaces of the two cylinders.

In Fig. 4, the side cylinder is the same length as in Fig. 3, and is 1½ in. in diameter, the vertical cylinder is 2 in. diameter and 2½ in. long, and its base is ½ in. from the border line. The half circles should be divided as shown (for a larger circle, more spaces, and the half circle should be divided into an even number) and points projected as in Fig. 3.

This shows that the line of intersection of the cylinders is a curve instead of a straight line as in Fig. 3 and we see that cylinders of the same diameter intersect in a straight line, while those of different diameters show a curve.

Problem 5.

Find the line of intersection of a cone 2 in. in diameter and 3 in. high and a hollow cylinder which is 2 in. in diameter and 3 in. long with a bore of 1¼ in.

Fig. 5 is directly under Fig. 2 and the base of the cone on a line with the base Fig. 4.

Divide the base circle of the cone into even number of parts and project down to front view and draw in the elements; also draw the corresponding elements in the side view. The elements of the surface of the cone intersect the circles of the cylinder, therefore, projecting the points to their respective elements in the front view of the cone the lines of the intersecting surfaces may be found.

Projecting from view to view onto the same elements, the location of the points in all the curves will be easily determined and then they may be connected with the French curve.

Finish the top view with all curves necessary to show the intersection of the surfaces.

PLATE XII.

Plate XIII represents a block having an outline something like a house with a roof over it and having a round, pointed tower passing up through one side.

The problem is to find the lines of intersection of the round tower with the roof; also the tower with the side of the house.

The body of the house to be 8 in. long and 3½ in. wide and 3 in. high, and up 1½ in. from bottom border line. The point of the room to be 4½ in. above floor of house and to slope at an angle of 30°. The roof of the tower is to have the same slope as that of the house. Simply continue the house roof until it intersects the center of the tower.

Center of house and tower 5½ in. from left border line of sheet. Center of house in top view to be 3 in.from top border line. Center of house in side view to be 3¼ in. from right border line and 1½ in. between center of town and center of house. Let the roof project ½ in. on each end of the house and the roof of the tower to be ¾ in. high measured in its center line down from the point.

Divide the circle of the tower in the top view into an even number of parts front view.

as shown and lay out elements in the front view by projecting down from the top; also the elements in the end view are as in the front view.

The intersection of these elements in the end view with the roof are to be projected horizontally to the front view, where they will cross the lines projected from the top view.

Draw in the line through these points with a French curve.

The dotted outline of the house body will indicate where the circle of the tower intersects the side of the house and this can be projected to the

(To be continued.)

Undiscovered Merit.

"I have been some time in this world, and the result of my experience is that there is one way by which success may be obtained with ability. In all my life I have never known an instance of undiscovered merit. There are too many seekers to allow ability to remain hid. If you possess ability and were placed in a diving bell and lowered to the bottom of the sea, expeditions would be fitted out to discover you and bring you back.

"No matter what calling you embrace, if you have ability you will be in demand. If a lawyer, think how many persons there are in trouble who would be seeking your advice. If a physician, how many there are who are ill who would want your services. If an architect, how many who desire better houses built. I have heard it said that a young man needs a pull to get a start. Pay no attention to that. If you have ability you will win."—The Hon. W. Bourke Cockran, in an address to the graduates of Manhattan College.

(Continued from page 79)

been left out since we were considering only the fundamentals. In actual practice friction plays quite an important part especially with the screw, worm gear and wedge where the work absorbed by friction often amounts to several times the useful work done, thus the applied force in practice is greater than the theoretical by an amount equal to the work absorbed by friction.

CURRENT TOPICS.

A Draft.

TO draw or not to draw, that is the question;
Whether 'tis better in the pride to suffer
The sting of fault in some blue penciled tracing
Or to take heart 'gainst these accusing tokens,
And by erasing end them. So to rub,
To ink, and by redrawing say we end
The error of some misfit iron-work,
That makes the shop to swear and loudly wish
The drafting room were being slowly warmed
In a forced draft.

'Twere better so to draw
(Weighing with care the length of every line)
That when the fiend attempts to pierce thy soul
With his blue pencil, he shall find thee armed
In the security of right dimensions.
Thus if you may; if not, draw anyway;
For if you draw no lines, you draw no pay.

P. H. W.

The next division of Elementary Drawing in the Home Study Department will be The Development of Surfaces, or "Pattern Drafting."

Some Drafting Room Practice is a new division of our magazine in the March number.

?

Why not keep a card index of information for your subscribers, as to what kind of treatment can be expected from any certain firm a man may be going to work for? Hasn't an employee as much right to be particular as to who he works for as an employer is about who he hires? There are some people who could not get you to work for them at any price.

Haven't shops been "bitten" so often by correspondence students that you destroy a chance of being hired by saying you are a Scranton man? In the language of a chief in a structural shop near Cleveland: those Scranton solicitors have flooded the market with silk purses made out of sow's ears. Draftsmen of the kind wanted are as scarce as ever, according to a "choicy" chief who gets to pay what he pleases for men?

Your subscription will be extended 3 months if you send in a new subscription.

If you are a subscriber and can secure others, send for list of premiums.

A list of premiums for subscribers. Get paid for your work. Send now.

An engineering course, free, for securing subscribers to the DRAFTSMAN.

The Money Value of a Technical Education.

THE presidential address on "The Money Value of Technical Training," delivered before the American Society of Mechanical Engineers this week, will be likely to arouse considerable discussion, in private, if not in public. It is somewhat unusual to publicly weigh the advantages of education in dollars and cents, although it is common enough to do so in considering the practical questions of how long a boy shall continue in school and what course of study he shall pursue.

No one will dispute that Mr. Dodge's statistics are probably fairly accurate as a gauge of the relative earning power at the present time of typical young men trained in different ways; but it may well be objected that these figures tell only a part of the story, and that they are likely to be misinterpreted by the public.

On the face of the returns, the average man will have a salary of $41 at the age of 30 if educated in a technical school, as compared with $24 a week if he has only a trade school education, or about $16 per week if apprenticed to the machinist trade. Naturally, therefore, the ambitions parent decides that a technical education is the thing to give his son; and naturally, also, the multitude of engineering schools in this country, small and great, are overcrowded with students.

It must be remembered that there is another side to this picture. The four classes of men whom Mr. Dodge represents in his diagram are doing different classes of work, and it is because of this that such a difference exists in their rate of wages. If the graduate of an engineering college cannot find professional or executive work to do he may have to take a foreman's place along with the men from the trade school, or he may have to join the union and work at the lathe alongside the man who learned his trade as an apprentice in which case the chances are that he will find more difficulty in securing and keeping a job than the man who has been used to the work from boyhood; or again he may have to step a peg lower and compete with the unskilled laborer.

Accepting this as a fair statement of the case, it follows that whether a technical education pays in any individual case will depend upon the relation between the supply of and the demand for the men of such training. It is undeniably the case that in any industrial establishment there are ten or a hundred places for those who work with their hands to every one place for those who direct the work. Industry is carried on to make profits, not to furnish employment; and if there is a surplus of engineers they will have no better chances for employment than a surplus of laborers, in fact not so good, for they cannot so readily turn to some other occupation.

The lesson to be drawn from Mr. Dodge's statistics, therefore, is not that it pays to give a boy a technical education. It may pay or it may not. What Mr. Dodge shows is that for the boys who get and keep their positions it does pay, and from the point of view of the general welfare of industry it undoubtedly pays.

It may be said, indeed, that from the point of view of the industrial welfare of the nation the more boys trained in technical schools the better, for there will then result competition between them and a "survival of the fittest," whereby the best and ablest will be "naturally selected" for the available positions. This is actually going on all the time, and within reasonable limits no one can object to it. Beyond those limits, however, it involves an amount of suffering, disappointment and loss that can hardly be contemplated with equanimity.

If there are next year, let us say, a thousand places to be filled with graduates from mechanical engineering courses and three thousand men are being educated to fill those places, it follows not only that two thousand will have to suffer disappointment, but that the thousand who do secure positions will be paid lower wages because of the fact that so many are applying for the positions.

It is for this reason that we always feel whenever the profits of technical training are publicly advertised, like uttering a warning to the youths who may thus be induced to enter the engineering profession. As they look at Mr. Dodge's diagram they will do well to reflect that the average graduate of a technical school who at 30 years of age is earning his $41 a week is earning it by just as hard work as the machinist who at the same age gets $15.30 in his weekly pay envelope. The graduate, to reach the position he holds, has had to devote six years of his life to hard study, during which time he earned practically nothing, and was under heavy expense. He made this investment, moreover, with the risk that it would turn out unremunerative. Perhaps he may prove unfitted for an engineer's life, perhaps in the struggle of competition another man will come out ahead, and leave him to take a subordinate place, or to remain unemployed. If he does succeed in securing his $41 a week position, it carries with it heavy responsibilities and risks. Taking all these things into consideration, the added earnings of the engineer over the laborer represent no more than a reasonable compensation for his expenditure of time and money.

We have taken pains to set forth these facts, not in dissent from or in criticism of Mr. Dodge's interesting address, but in order that it may not be misinterpreted. We would say no word to discourage from an engineering career the boy who is fitted for it by natural ability, and who starts with a clear appreciation of the difficulties and risks before him. Nor would we say one word to dissuade from pursuing a course in an engineering school any young man whose financial circumstances are such that he can well afford the necessary time and money, and who seeks the training as an education and not merely as a means of aiding him to earn a living. It is to a third class that words of warning need to be sounded—the youths who are making sacrifices for an engineering education with no particular fitness to make use of it in after life, and who will set no greater value upon it than can be measured in terms of dollars and cents. It is when it is expended on such men that technical training does not pay.—"*Eng. News*"

Ellipse or Circle Compasses.

THIS invention relates to improvements in ellipse and circle compasses, the object of my invention being to provide compasses for drawing ellipses, either with pencil or with pen, which shall be cheap and simple in construction and convenient of operation, compasses, moreover, which can be adapted, when desired, for drawing circles.

In the accompanying drawings, Figure 1 is a front elevation of my improved compasses. Fig. 2 is a side view thereof. Fig. 3 is a side view of the inking-pen detached, the wall thereof being broken to show a spring in the interior. Fig. 4 is a plan view of the compasses. Fig. 5 is a perspective view of the spreader detached.

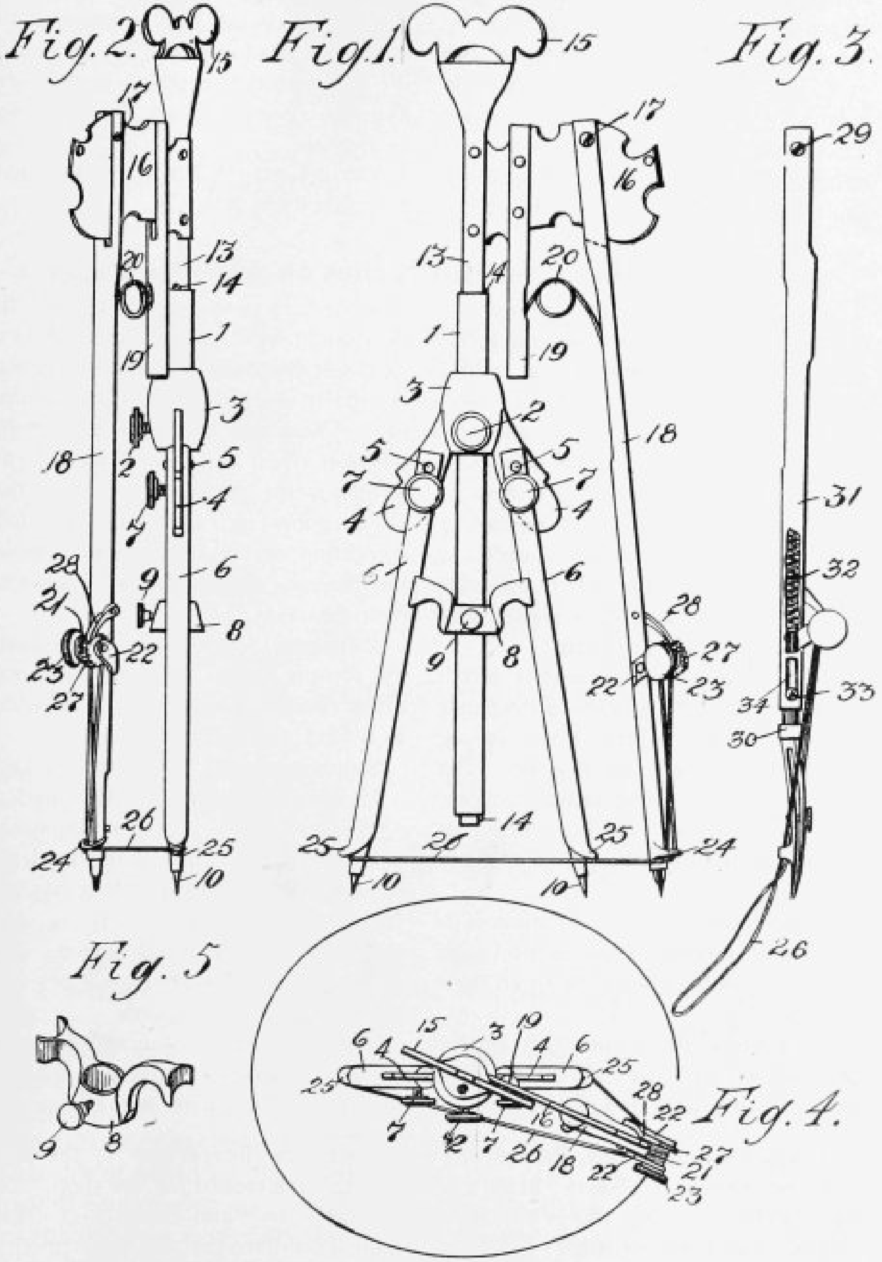
Referring to the drawings, 1 represents a central tubular stem upon which is clamped, by means of a set-screw, 2, a collar, 3, having depending tugs, 4, upon which are pivoted, as shown at 5, the legs, 6, said legs being also clamped at any desired angle to said tugs by means of set-screws, 7.

Eight represents a spreader, which is set by means of a set-screw, 9, at any desired point on the tubular stem below the collar and serves to spread the legs apart to an equal distance on each side of the stem. In the ends of said legs are carried pin-points, 10, which determine the foci of the ellipse to be described. By properly adjusting said collar and spreader the focal distance can be made of any desired length.

Revolable within the tubular stem is a rod, 13, having pins, 14, at the ends of the stem preventing its longitudinal movement in the stem. Said rod is provided at the top with a suitable handle, 15, and to said rod is clamped a plate, 16, having pivotally secured thereto, as shown at 17, a pencil-carrier, 18. To said plate is also secured a depending bar, 19, which forms a support for a spring, 20, the other end of which presses against the inner surface of the pencil-carrier, which is hollowed out for this purpose, said spring thus pressing said pencil-carrier outward.

Twenty-six represents a cord of inextensible material, as catgut or wire, preferably the former, which is doubled and wound around a small winding-pin, 21, carried in bearings, 22, upon the pencil-carrier and wound by means of the head, 23. The loop of said cord is passed through an eye, 24, carried at the lower end of the pencil-carrier, and is then passed around the ends of the legs, 6, immediately above the pin-points, 10, said ends being provided with shoulders, 25, at substantially the same level as the eye, 24, which prevent the cord slipping upward on the legs. The winding-pin also carries the ratchet-wheel, 27, engaged by a pawl, 28, upon the pencil-carrier, preventing the loop of catgut being drawn out beyond a predetermined length. This length will be the sum of the focal distances of any point on the ellipse, and since the length of the loop remains constant, and the focal distance of the ellipse, determined by the distance between the pin-points, is also constant, the remainder of the loop will be a constant quantity, and, therefore, by the well-known property of the ellipse the pencil will, as it rotates about the foci, describe an ellipse.

The spring, 20, keeps the loop or cord always taut, as it constantly presses outward the pencil-carrier.



In Fig. 3 is illustrated the drawing-pen, which is used for inking the ellipse. Like the pencil-carrier, it is provided with a pivot-hole, 29, by which it is pivoted to the plate, and the end, 30, of the inking-pen is movable relatively to the main body or stem, 31, thereof, the latter carrying a spring, 32, which normally presses down the point of the pen, the lower section having a stud, 33, sliding in a slot of the main body.

If desired to use the device as a circle compass, all that is necessary is to slip the cord over the end of one of the legs, when the pencil-carrier will describe a circle about the other leg as a center.

The inventor is Mr. John W. Griffith, San Francisco, Cal.

A Blueprint Paper for Blue Lines on a White Paper.

The following process, credited to Captain Abney, yields a photographic paper giving blue lines on a white ground:

Common salt	3 ounces.
Ferric chloride......	8 ounces.
Tartaric acid.........	3¼ ounces.
Acacia	25 ounces.
Water	100 ounces.

Dissolve the acacia in half the water, and dissolve the other ingredients in the other half; then mix.

The liquid is applied with a brush to strongly-sized and well-rolled paper in a subdued light. The coating should be as even as possible. The paper should be dried rapidly to prevent the solution sinking into its pores. When dry, the paper is ready for exposure.

In sunlight, one or two minutes is generally sufficient to give an image while in a dull light much as an hour is necessary.

To develop the print, it is floated immediately after leaving the printing frame upon a saturated solution of potassium ferrocyanide. None of the developing solution should be allowed to reach the back. The development is usually complete in less than a minute. The paper may be lifted off the solution when the face is wetted, the development proceeding with that which adheres to the print. A blue coloration of the background shows insufficient exposure, and pale-blue over-exposure.

When the development is complete, the print is floated on clean water, and after two or three minutes is placed in a bath, made as follows:

Sulphuric acid......	3 ounces.
Hydrochloric acid...	8 ounces.
Water	100 ounces.

In about ten minutes the acid will have removed all iron salts not turned into the blue compound. It is next thoroughly washed and dried. Blue spots may be removed by a 4 per cent. solution of caustic potash.

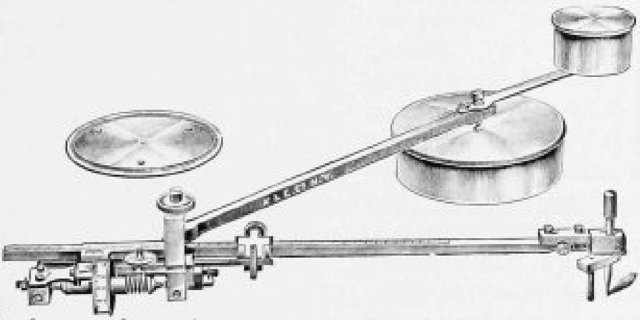
The back of the tracing must be placed in contact with the sensitive surface.—*Drug. Circ. and Chem. Gaz.*

Mr. L. D. Burlingame, chief draftsman of Brown & Sharp Mfg. Co., says: "The drafting office has three distinct functions to fulfill. First, it must be an interpreter *to* the shop; second, an interpreter *of* the shop; and third, a record *for* the shop." This is exactly true and every chief draftsman should see that his department of the work is fulfilling its function.

A New Book on Planimeters.

That the Polar planimeter and other instruments of its class have not received the attention or come into the general use by engineers to which their invaluable characteristics entitle them can be due only to a lack of knowledge of those characteristics and of the invaluable aid which these instruments are capable of rendering in almost every form of engineering calculations.

Were these operations limited to measuring the area of a plane figure and determining the average mean height of an indicator diagram, with which operations these instruments have heretofore been most commonly associated, the accuracy and rapidity



with which they perform these operations would alone make them of the greatest value to the Engineer, but when to these is added the ability to mechanically and with almost incredible accuracy solve almost any problem occurring in the Engineer's practice and with a saving of time and labor impossible by any other means, the Polar Planimeter becomes at once *the* indispensable instrument of the Engineer's equipment.

That the aid which the Polar Planimeter is capable of rendering in almost any branch of Engineering and Scientific work has not been more fully recognized has been due to the fact that up to the present time the principles underlying the theory and use of the instrument and their application to the processes of applied mathematics have neither been adequately studied nor given the position in Engineering literature to which their importance entitles them.

These considerations have led to the publishing of *The Polar Planimeter and its use in Engineering Calculations.*

The Author of this work is Mr. J. Y. Wheatley, C. E., the American authority on these instruments. This book contains not only a clear and concise description of the Polar Planimeter and the theoretical principles involved in its construction and operation, but also explains in detail the application of the instrument to the solution of nearly all of the most commonly occurring operations of engineering practice. It includes also very complete Tables of Factors and other data for the immediate adjustment of the Planimeter for these operations, thus making the book not only a treatise on the instrument, but also an office book for constant use,

Large Octavo, Cloth, with 12 Plates, New York, 1903, $3.00. Published by Keuffel & Esser Company, 127 Fulton St., New York.

Crokett's Trigonometry.

A rigorous, compact yet simple text coming from Rensselaer Polytechnic Institute. While the book is peculiarly adapted for use in technical institutions, it finds a proper place wherever facility in the use of the tables is required. Special care has been taken to have the tables absolutely correct, in the last decimal place. The arrangement of the computations, for the convenience of students, has also been made as nearly perfect as possible. The book can be used by beginners, but it is intended to furnish a thorough course.

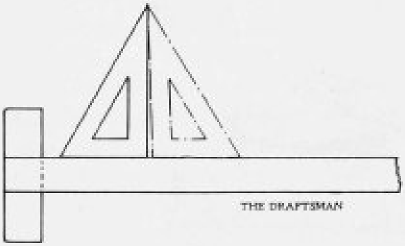
Published in four forms:

Elements of Plane and Spherical Trigonometry With Tables...... ....$1.25
The same, Without Tables..... 1.00
Logarithmic and Trigonometric Tables Separate 1.00
Elements of Plane Trigonometry With Tables 1.00

The American Book Co., 317 Walnut St., Cincinnati, O., publishers.

To True up a Triangle.

Triangles are seldom tine when first received from the factory, often



a long 30-60° one will show two lines when one is drawn as in position, and when the points are placed on the vertical line, but in the reversed position.

If the two positions do not fit the same line, the angle at the base is not 90° and can only be made as by filing off along the base.

Triangles have been known to wear off more at the heel than at the points and most of them would set as shown in the two positions than otherwise.

A straight flat smooth file is the best to use in working the triangle into shape.

The United States is now the greatest coal-producing country in the world, the output of 1903 reaching 300,000,000 tons. This is four tons of coal for every man, woman and child in the United States.

With 385 pounds of smokeless powder the new forty-calibre, twelve-inch gun will send an 850-pound armor-piercing shell through nineteen and five-tenths inches of Harveyized nickel-steel armor at a distance of a mile and a half.

A tree using aluminum almost to the exclusion of other mineral elements has been reported in New South Wales by H. G. Smith, of Sydney. It is known botanically as Orites excelsa, R. Br., and the aluminum is deposited as a basic succinate. Other flowering plants show only a trace of aluminum, although it seems to serve as a food of cryptograms.

It is not against the law to transact a legitimate business under an assumed name.

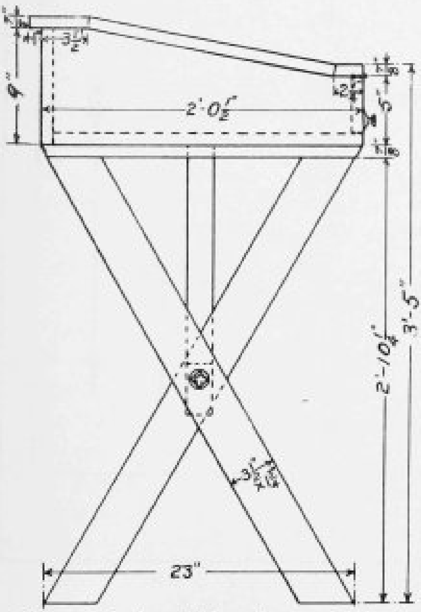
Central Institute.

(Continued from first Arttcle)

and for those students who cannot be accommodated with lockers in the tables, a lot of extra ones are provided in the wall of the room which will hold everything except the drawing board.

As will be seen in the sketch, the top of the table has some slope. This might or ought to be less than here shown for the squares and instruments are constantly sliding off onto the floors.

Perhaps it would be better to have the table flat with elevating blocks to slip under the boards if desired. The end piece of the table could be run through and two tables formed in one if desired and in one of the rooms, the tables are so made.



Some of the tables have six lockers, each 2ft.—5½in. long, which with the dividing pieces and overhand of the tops make these tables 16 ft. 0 in. long, with three sets of legs each.

Each locker is provided with a miller lock, which operates like those on safes, each student keeping in mind the combination of his own.

The majority of the drawing boards used are 16x21 in., though 18x24 in. could be handled nicely.

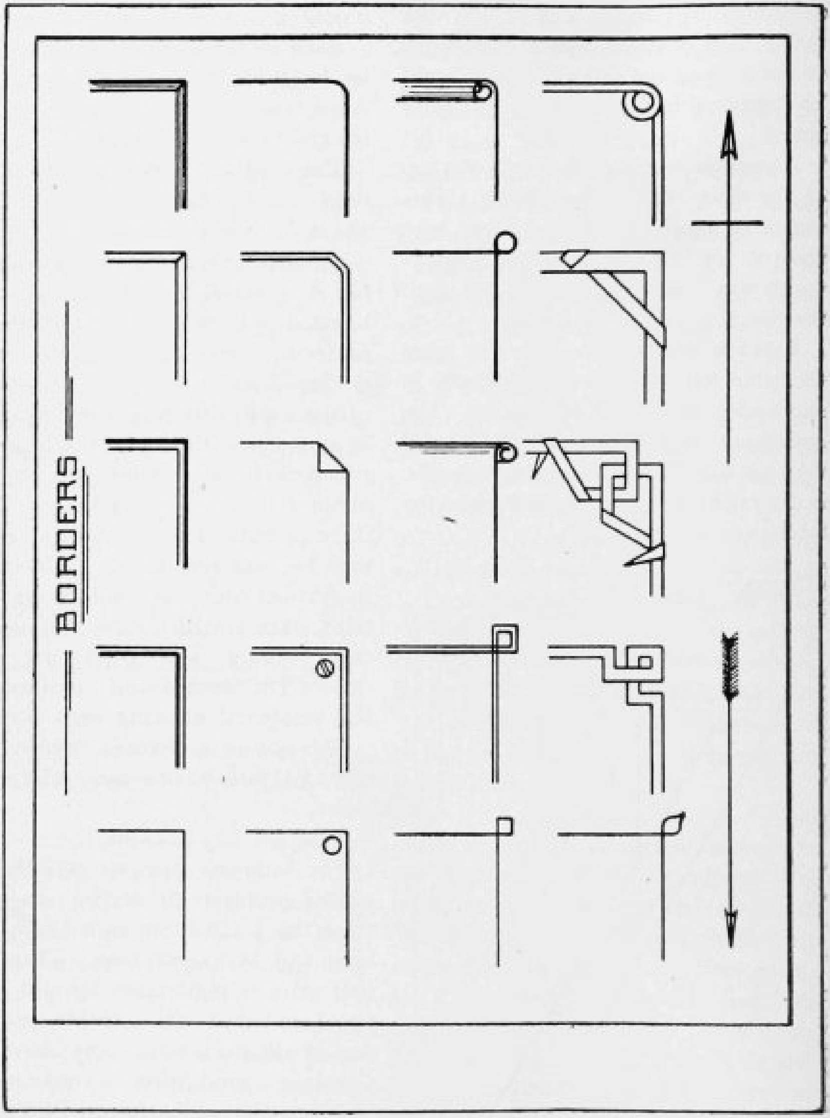
Stools are provided for the students, but it is found that many are too interested in their work to sit down, but prefer to remain standing.

Classes are in session four evenings of the week, fifty weeks in a year, but in most cases, the student only spends two periods (one hour and twenty minutes') in drawing, there being three periods of forty minutes each in each evening and the third is taken up in mathematics. A student thus obtains some instruction in this science each evening and there are also classes in mechanical, architectural and structural drawing each evening.

The school is located corner Scovill and Willson avenues, Cleveland, Ohio.

The Industrie Zeitung says that of all the countries producing steel in 1902 the United States led, with an output of 15,000,000 tons. These figures grow in importance when it is remembered that the world's production in 1894 was only 12,851,000 tons. Germany's production in 1902 was 7,780,000 tons, one-half that of the United States, while England's was only 5,000,000 tons, or one-third the production of the United States.

Fancy Borders.



Some fancy border line are hereshown that can be used for general drawings and title sheets.

Labor World.

Work on the Indianapolis (Ind.) Labor Temple is expected to begin January 1.

The Trades Assembly of Duluth, Minn., wants free evening schools established.

Broommakers of Milwaukee, Wis., have received a thirty-five or forty per cent. raise in wages.

The Canadian Parliament has passed an enactment that Asiatics shall not be employed on Canadian roads.

Sheep butchers throughout the country have accepted the wage increase of twenty-five cents a day that was offered by the packers.

Membership in the Journeymen Blacksmiths' national organization has increased an average of over 2,000 per month in the last year.

There are nine 'longshoremen's workers' unions in Queensland, Australia, and they all belong to the Waterside Workers' Federation.

Indianapolis (Ind.) labor unions will try to secure the choice of that city for the convention of the American Federation of Labor in 1904.

There is a movement on foot to increase the number of members of the Executive Council of the American Federation of Labor to eleven.

At Boston, Mass., a resolution to organize the pearl button workers was introduced at the convention of the American Federation of Labor.

New Orleans, La., 'longshoremen have madé a three years' agreement for their work. This follows a prolonged and costly strike of 8,000 men.

Minnesota farmers at Kenyon built their own elevator seven years ago at a cost of $14,000. Their annual profits are more than the cost of the building.

A general reduction in the wages of engineers is demanded by the engineering employers in Belfast, Ireland, following upon the reduction in the shipyards.

The Pope Bicycle Daily Memomranda Calander.

The re-issue of the Pope bicycle daily-leaf calendar may be considered the opening gun proclaiming the natural and healthful return of bicycling. Col. Albert A. Pope, the founder of our bicycle industries and the pioneer of the Good Roads Movement, is again at the head of the bicycle industry. Upon the 366 calendar leaves are freshly written lines from the pens of our greatest college presidents, doctors, clergymen, statesmen and other eminent men and women, all of them enthusiastically supporting bicycling. Half of each leaf is blank for memoranda. This calendar is free at the Pope Manufacturing Company's stores, or any of our readers can obtain it by sending five 2-cent stamps to the Pope Manufacturing Co., Hartford, Conn., or 143 Sigel Street, Chicago, Ill.

A Progressive Patent Bureau.

Popular Mechanics, a publication which has come to the front in the past two years with leaps and bounds until it now has a circulation larger than any publication of its kind in the world, has inaugurated a patent bureau known as the Popular Mechanics' Patent Bureau, and from all evidences, it is as great success as the publication, which is undoubtedly well known to the readers of the "Draftsman." The Bureau is well organized, their attorneys and consulting experts are all practical men of large experience, and the bureau is, we understand, prepared to make research in the patent offices of this country and all foreign countries at a very moderate charge. Their charges for securing patents and prosecuting infringements and promoting the interest of their clients in every possible way, are very reasonable.

The bureau is rapidly extending its scope by having representatives in all the manufacturing districts of the United States and many subscribers of this publication who are conversant with patent work drafting would find it to their interest to represent this bureau in their locality, if no such agent has already been appointed, and we would advise communicating direct with the bureau whose main office is in Chicago.

The Patent Office of the United States was never more busy than at present. Under recent decisions of the Commissioner of Patents and the Courts, preference is given to the diligent inventor where there is any question as to who made the invention first. By diligent inventor is meant the one who first perfects his invention in practical form and applies for a patent.

Many inventors lose the fruits of their inventive ability through a disposition to procrastinate. This is truly a mechanical age, as realized by the progressive publishers of Popular Mechanics and inaugurators of Popular Mechanics' Patent Bureau, and the draftsmen of the country are certainly benefited by the great activity in mechanical lines.

"A Designer'sNightmare"

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

The Japanese Workman at the Worlds Fair.

THE work of the native draftsman and other artisans employed on the side of the Japanese government buildings and grounds at the World's Fair is now well under way and is proving distinctly interesting to the general public.

It is natural that this should be the case, owing both to the unusual methods of these workmen, as judged from the American point of view. and to the high artistic values of the results attained. In many instances the tools used by the Japanese are operated in exact reversal of the American style—their saws, for example, being so made that the teeth cut into the wood only when the saw is drawn towards, not pushed from the body, and their jack-planes working in similar manner—and this fact is in itself sufficiently out ot the ordinary to attract the widest attention. Then, too, the buildings, gardens and grottoes being constructed are Japanese to the minutest detail and their smallest features are new and novel to the average citizen of this country.

It is, therefore, a picturesque object lesson that is now being presented by the preparation for the Japanese government exhibit at the World's Fair. Japan proposes to prove to the world that she is abreast of the most modern

(Continued on page 140)

MECHANICAL.

Mechanical Misconceptions.

BY R. T. STROHM.

THE patent office records are full of descriptions and illustrations of devices whose sole claim to the protection of patents lies in the fact that they are original and unique applications of recognized principles, and not because they possess any real commercial value. They were conceived after much thought and study, if one may judge from the ingenious combinations brought forth. But after being patented they were forgotten. Apparently their action was faulty, or else they failed to do as well as other devices already widely used for similar purposes.

The energy represented by these abandoned conceptions of ingenious minds is enormous. The pity of it all is that it has been put forth with so little value returned. Yet in nine cases out of ten the whole cause of the failure is due to the fact that the inventor has misused or misinterpeted some well-known physical law. And further, if the inventor had but had a proper understanding of the laws which he must apply he would have foreseen the difficulties he must encounter and would have been saved the loss of time and labor.

Illustrations of errors of this nature are many and various. One man who was very much interested in the improvement of the steam engine, became very much concerned about the pressure upon the ordinary slide valve. He knew that it not only caused excessive friction and wore out both valve and seat very rapidly, but that the power expended in moving it was considerable, and that a reduction in pressure on the back of the valve would result in a decrease of wear, friction, and lost work. Actuated by the idea of improving the slide valve, he brought out the type shown in Fig. 1. Instead of the usual flat back he had made a pyramid. His idea was that the steam, in pressing down on the sloping sides, would slide off, as rain runs from roof of a house. Of course his reasoning was wrong in that he had not observed the fact that a fluid presses in all directions with the same intensity and not in a single direction, as would be the case if the same total pressure were applied vertically through the medium of a short pillar having its lower end resting upon the inclined valve surface.

Another instance of misconception of important physical laws may be cited. The writer was at one time called upon to pass judgment upon the utility and practicability of the device shown in Fig. 2. It represents the essential parts of a new form of steam engine consisting of two pistons, A and B, fitted to separate rods, one rod being carried through the opposite piston and rod to the outside of the cylinder, where each rod is connected to its own crank. Between the piston at the center of the cylinder is the steam port C, the steam being admitted between the pistons, forcing them apart, and causing each to make a stroke approximately half the length of the cylinder. The inventor of this scheme contended that it would be a very economical arrangement. He argued that in all ordinary engines the pressure against the cylinder head is equal to that against the piston, and that as the head is stationary half the power was being wasted. By his arrangement one piston became practically a movable cylinder head, so that the pressure exerted on each would perform work. This, in his mind, appeared to offer opportunity for great gains in power.

The fallacy of this reasoning is quickly shown. Mere pressure is not work. A cubic foot of cast iron lying on the ground presses against the earth with a force of 450 pounds. This pressure acts constantly, but no work is done or lost. The mere fact that steam presses against the head of the cylinder does not indicate a power loss. To produce work, force must move through space, the product of the force in pounds and the distance moved in feet being the foot pounds of work accomplished. In the case of the ordinary engine, the force on the head of the cylinder does not move through an appreciable distance and the work done is nothing. Further than this, it is absolutely necessary that the steam shall act against either a stationary or a movable head. Action and reaction are equal and opposite in direction. To produce any pressure whatever upon the piston, there must be an equal and opposite reaction against the head, whether it be stationary or movable.

An indicator, attached to the cylinder, would quickly show the fallacy of increased work obtainable. A card taken from a single piston engine whose stroke is equal to that of the two pistons, and having the same volume of steam at cut off, would appear as in Fig. 3. A card from the double-piston engine, reproducing the travel of each piston, would appear as in Fig.2. Comparison of these cards shows that they have equal volumes and pressures at cut-off and equal volumes and pressures at the end of the stroke, and that the areas are equal, indicating that the same amount of work is done in each case.

The two illustrations given serve to bring out the point which has proven such a common stumbling block. That is, ignorance of physical laws, upon which the success of the device is dependent, and disregard of which must inevitably end in failure and disappointment.

In order that any device may prove a success, it must embody a number of essential points. In the first place it must be practical and not merely a well developed theory. It must accomplish its purpose, and it must do so at least as well as, and preferably better than, any other device for the same object, with which it must compete. Its cost must not be prohibitive, nor greater than that of other similar devices of equal utility and efficiency. It must attain the purpose as simply as possible, since the greater the number of parts and the more complicated their arrangement, the greater is the liability to derangement and damage. Last of all, it must be durable. No owner of machinery likes to pay a high rate of interest on his investment for

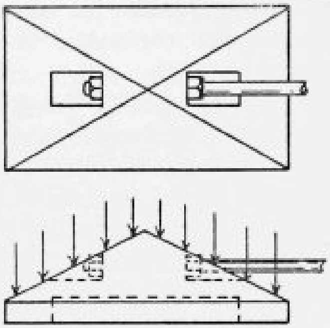


FIG. 1.

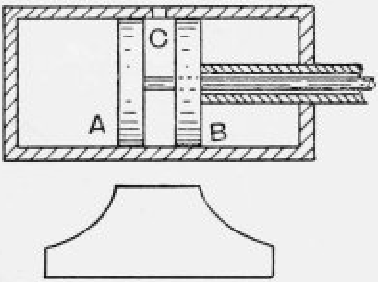


FIG. 2.

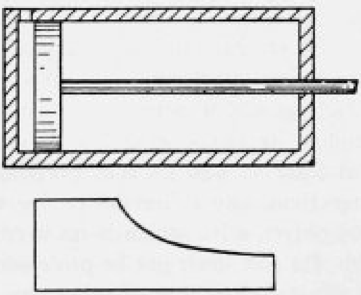


FIG. 3.

the supply of repairs, and the durability of a machine is a potent factor in its commercial success.

A Draftsman is an Inventor.

Vincent Link, who came here from Bellevue, O., some time ago to be employed as draftsman at the Geneva Automobile & Mfg. Company's plant and who is in charge of a small force of workmen at that shop, completed an invention last spring or summer, which is now being successfully used at a plant in Radford, Va.

C. W. Pratt and R. P. Morgan of this place began operating a skewer factory there this fall, and they desired a better skewer pointer than the old one used at the local skewer shop a number of years ago. Mr. Link said that he could make a pointer, and they told him to go ahead with it. So at odd spells, and outside of the company's time, he completed an improved skewer pointer at the automobile shop. He completed a machine which would make 2,000 points a minute, or point on both ends 1,000 skewers in that time. The above gentlemen purchased it, paying him about a fair price for it, and they are now using it in their Virginia skewer plant. The machine was kept stored at the automobile factory a long time before Messrs. Pratt and Morgan called for it.

Mr. Link is quite a genius, and it is understood that the company have in the past used many of his suggestions in regard to improvements and different devices on their machines.—*"Press Times,"* Geneva, O.

Engineers expect soon to be able to burn gas in such a continuous stream that it will be useful in the turbine form of engine.

Checknig a Drawing.

THE "checking" of a drawing is the equivalent of proof-reading in the newspaper office of the country.

It is the correcting and approving of the shapes shown and the figures given and should be done by some responsible person, one who understands the work in hand.

A drawing may be checked by simply adding up dimensions to see that they total the one given, and make observations to see that all parts will

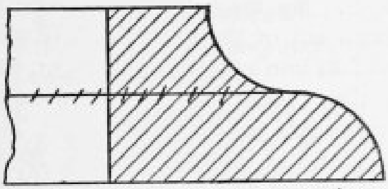


FIG. 1.

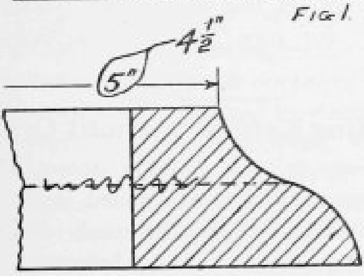


FIG. 2.

go together properly. Aside from this, no more is done by the "checker" in many cases, but in most drafting rooms, the checker goes into some points of the design, too.

When a line is shown solid, which should be dotted, the checker cuts his blue pencil (blue being used because it can be seen more easily) through the line as in Fig. 1 and if it should not appear at all, a wiggle is run through it as in Fig. 2.

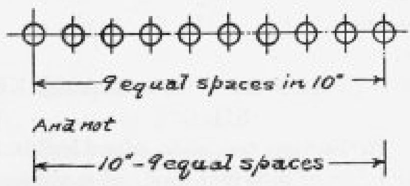
Dimensions that are to be changed are noted by surrounding the offending figures and carrying the mark to one side as in Fig. 2.

Since, in many drafting rooms, the tracing is checked and not the drawing, some care should be exercised in marking with the pencil, for in erasing it, later, the surface of the cloth is much disturbed and tracing so treated look very badly.

The spelling and arranging of the titles and notes are also looked at and such corrections made as are necessary.

The best plan is that the checker should first look over the drawing and make such alterations as he has authority and ability, then it is traced and checked more closely.

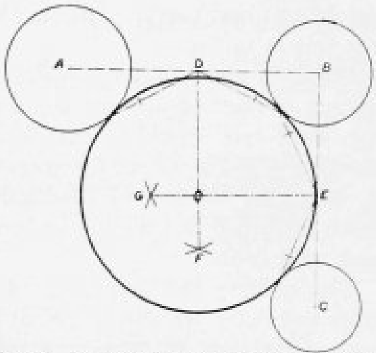
In the case of noting the numbers of spaces for rivet or bolt holes, it would be better to have it appear thus:



for by writing in the note, the number of spaces is more correctly given, though a hole or two more may be shown, the note is the thing to be followed, not the picture.

Editor The Draftsman:

I was interested in Mr. MacDonald's construction in your January number, i. e., to describe a circle tangent to three given circles whose diameters are different, and herewith submit the following:



Let A, B, and C be the centers of the three given circles whose diameters are different. Join the centers A and B, also B and C. Bisect any two of the distances between the circumferences, in the points D and E, and from these points draw lines tangent to each of the circles respectively. Bisect the angles thus formed at D and E by the lines D F and E G, intersecting at O. The point O is the center of the required circle. D. J. MacLean.

DIFFERENCE IN MACHINE SHOPS.

In Europe one shop often builds a number of different kinds of machines, while in America, as a rule, each factory is devoted to some special machine.

Coke Drawing Device

A machine for drawing coke ovens is in use at Continental No. 1 works of the H. C. Frick Coke Company, one mile from Uniontown. It has been inspected by operators from the entire coke region, and has proved a decided success.

Under the old method one man draws an oven of coke in about three and a quarter or three and a half hours, or an average of two and a half ovens a day. The new machine draws about two and a half ovens an hour, and only one man is required to operate it. By the machine the coke is drawn out of the ovens by a scraper and falls into a receiving conveyor, and is then taken along and dumped directly into the car for shipment. The machine was invented by J. A. Hebb, of Hopwood, this county, who worked on it for nine years.—Philadelphia Press.

Boiling Kettles without Coal

Every day in London scores of workmen's kettles are boiled in lime that will afterwards be used for its proper purpose. Just before the breakfast hour, say, one of the workmen empties a quantity of the dry lime from a sack. In the center of this lime he makes a hole, and into it water is poured. Then he puts his kettles into the water, and in a few minutes the kettles boil. In thousands of cases a fire is thus spared.

The fact that 75 per cent. of the central electric stations of the United States are in places of less than 5,000 inhabitants, as compared with 22.8 per cent. of the gas plants, indicates the wider distribution of the electric stations which have enabled the inhabitants of the small places to enjoy illuminating facilities confined heretofore to the larger cities and towns.

ELECTRICAL.

The Young Electrician in the Machine Shop.

BY GEORGE E. WALSH.

ELECTRICITY has become such a common factor in our industries that a practical and theoretical knowledge of it in the shop and drafting room are almost essential to success.

As a whole the subject is too comprehensive for one to study without particular reference to the different specializing tendencies. The modern electrical engineer devotes his attention either to telephone construction and operation, to electrical railway building and work, to electric lighting and heating, or to electrical shop equipment. Each of these several specialties are further divided and subdivided, and there are marine electrical engineers, architectural electrical engineers, subway electrical engineers, and submarine electrical engineers.

In the shop, however, electricity is chiefly a factor in the operation of machines. The engineer who installs the shop with its electrical equipment must be one who can study out the problems of economy of space and operation. The displacement of steam-driven machines by electrical-driven ones can be accomplished only by a perfect demonstration of the latter's superiority. There must be economy of time and output, and a saving of power. Usually the properly equipped electrical shop saves in many ways. With multispeed motors for driving tool machines there is a distinct saving in time, power, and output.

But space is always an important consideration in equipping a shop or factory with motive power. As a rule the electric equipment requires less space than steam. A good deal depends upon the planning and designing of the engineer who has the installation in charge. The young electrician in the shop never had better opportunities to show originality and skill in designing and planning. So much of the work is largely experimental today that manufacturers of tool machines are required to build many which can be easily adapted to steam or electricity for driving. A good many shops will not entirely abandon steam, but use it as an auxiliary power. This skepticism or conservatism indicates the attitude of many old shops toward electricity. They are willing to give it a trial, but they are not entirely satisfied that there will be no breakdown or unforseen trouble.

However that may be, the knowledge of practical electricity should be a part of the education of every worker in the shop or drafting room, for the use of this agent for power purposes will steadily increase, and in time it will entirely displace steam. In a dozen different ways a practical knowledge of its working force will help one in his daily work. The young electrician who makes a study of shop equipment cannot do better than to specialize his knowledge. There is need for specialists who can rise above the average, and plan and design work which few electrical students know how to do. There are many shops so narrow and cramped that the placing of electrical machinery in them to occupy as little space as possible becomes a problem. There are corners in shops which owing to the position of some explosive substance it is impossible to introduce steam pipes, and the young electrician should be able to plan his work so that tool machines could occupy such corners without introducing the element of danger at all.

The operation of electrical-driven tool machines is a part of the daily routine work of most large shops today; but the skilled operator who understands his business will not rest content with simply running the machines. Any one with a little practice can do this. The mere turning on and off of the current is the work of boys, but the manipulation of the machines so the highest efficiency is obtained from them is quite another matter. The life of a tool depends upon its manipulation fully as much as upon its use and original composition and manufacture. Electrical-driven tool machines are after all delicate mechanism, and they need to be handled by experts. In a good many shops it is difficult to secure proper workmen to handle the new multi-speed motors, which work with wonderful results when operated by skilled mechanics. They have a high degree of efficiency, and for every instant that they are working they economize in power and results. There is no waste of power through idleness or ineffectiveness.

But such tools can easily be run out of order, and their repairing is not a simple feat. The repair bills of a modern shop too often present a formidable item. Shop economists today are studying this end of the work. Good machines to begin with will necessarily cut down the repair account; but fully as important in this respect is the skill or lack of skill of the operators. The tendency of modern industrial life in and out of the shop is to secure the highest skilled labor, and pay well for it. It is the man-power efficiency that is coming in for investigation and test. We have perfected our machines to such a point that we hear much of their highest efficiency, and now the shop is tending toward the elimination of the inefficient workmen, and raising the standard of those remaining behind.

In nothing is this better illustrated than in the demand for shop workers of all kinds who have a fair working knowledge of electricity. Is it possible to turn over an electrical-driven set of machines to an operator who is not familiar with the mechanical part of electricity? It is possible, but not practical. A man might study the method of manipulation of levers and handles, and yet not understand the reason for the machine's steady operation. But in the event of some little trouble, some slight shifting of the load that causes a stoppage, some little breakdown or cutting off of the current through tangling or crossing of wires, would such an operator prove of much value? In small shops it is not always possible or practical to have an expert electrical engineer within calling distance at all hours of the day. With only a few electrical-driven machines on hand, such an expense would rob the shop of all profits from the new machines. Consequently the operators themselves must know how to manipulate the machines, and how to discover slight troubles that may develop, and also how to keep the machines and the wires and belts in proper smooth running order. In other words, the ordinary machine operator must be somewhat of an electrician. There is no line drawn as to how much of an expert, but the more proficient he makes himself in this line the more valuable he becomes to the shop.

The electrician who plans the installation of the new equipment finds that his labor is largely measured by the thoroughness of his education and skill in his specialty. The higher mathematics of electricity cannot be taught in text-books; it must come from practical study and experience. The inquiring mind in the shop is always open to new suggestions and discoveries. It is ready to find some new kink that may at the opportune moment prove of more real value to the shop than half his theoretical education. The open, receptive and studious mind is in a fair way then to become an inventive mind. Invention is not after all the result of sudden inspiration so much as it is unconscious reasoning out of some simple principle. From our shop workers there have come many of our best inventions. Thrown into daily contact with their machines they see better than outsiders where improvements can be made. A poorly working machine, or a clumsy mechanism that only half does its work, should be an offence in the eyes of an expert engineer or mechanic. There is something wrong in the principle or its adaptation.

In the electrical field there is a wider margin for invention and improvement than in almost any other. New methods of equipping the shop with machines and labor-saving implements must constantly raise the standard of the shop. In a good many instances a general invention could not accomplish the results desired. Peculiar conditions of adaptation prevail, and it is the skill, invention or common sense to do this that makes one electrician superior to another.

"We cannot lose such and such a man, no matter how many others we must lay off," is frequently the decision of shop superintendents. "He is invaluable because he knows every detail of the shop mechanics." In another shop, the conclusion is reached: "We expect a good deal of that man because he has already made valuable suggestions. Inventions? No, they can hardly be called inventions; you couldn't patent them; but they are worth more than inventions to us. They have systemized our shop, and eliminated waste practices."

In times of industrial depression the valuable man is the last one to be laid off. His work has made him a necessity to the mill or shop. The practical electrician who can repair and improve the machines is a man of this sort. Another who can adapt the mill operation so that money is saved to the firm is a second invaluable attache. The simple grouping of machines to be driven by electricity so that the least amount of power is used for given results is a matter that is decided before the shop is equipped; but sometimes it is desirable to throw out of the group a number of machines. The shop is not running at full force. Depression in trade is causing mills to economize in production and to limit the output. The detachment of machines from the different groups so that the highest efficiency can be obtained from those kept running is a matter not easy to accomplish. Outside expert advice costs money and many shops are opposed to calling in outside professionals. At such times the man within the shop who has made himself an expert will meet his opportunity. He will rise to the occasion, and prove his worth. The wisdom of keeping just a little ahead of his profession, and not simply abreast of it, will be demonstrated.

The reconstruction of old shops is going on today as never before. It is not always possible or profitable to tear down the old and build up new. But the old plant must be brought up to date. The newest equipments must be installed. It is a costly undertaking sometimes to reconstruct a shop, and manufacturers hesitate some time before giving the order. Expert outside consulting engineers and electricians hold their services ready for such emergencies, but they come high, and the expenses at all times must be considered in shop reconstruction.

A good many of the old wooden shops were not built to accommodate modern electrical-driven machines. The roofs and side beams are not strong enough to withstand the vibration and extra load. Car repair shops of the leading railroads are nearly all of this character; but their interior equipment must be brought up to date, and it is being accomplished.

The question of gradually reconstructing the shop to suit modern conditions is one that requires the most study, and the shop superintendent or electrical engineer who can so plan this work that there will be little interruption of work is a man of much worth to the company. During dull seasons a part of the shop can be turned over to him, and when this is installed with new machinery he can turn to another portion. The problem of strengthening the roof and wooden sides in places where the heavier machines will be located must be considered. There are a number of railroad repair shops that have thus been revolutionized in the course of a few years so that they are the most efficient in the country today. They were transformed through the intelligent cooperation of the inside men, with scarcely few outside suggestions beyond those given by the machinery company's experts, whose services were freely at the purchasing shop's disposal. A shop that has inside workers of this type is fortunate, and it is not likely that they will be dropped from the pay rolls except under extreme commercial depression.

Some Electrical Data.

I AM sending you some tabulated data on current capacities for various electric incandescent and arc lamps, which will be of value to readers of the "Draftsman" engaged in electrical drafting as well as to others desiring the information, without being compelled to consult various textbooks or catalogues and running the risk of not finding exactly what is wanted.

M. H. ABREMOVICH.

Current in amperes for a 16 C.P. lamp

Watts per C. P.	2.5	3.0	3.5	4.0
220 Vots	....	....	.26	.29
110 "	.364	.436	.51	.58
100 "	.40	.48	.56	.64
50 "	.80	.96	1.12	1.28

Note:—For a 32 C. P. lamp, ampere capacity is doubled.

Current in Amperes for open Arc Lamps.

Nominal Candle Power	Constant current circuit 45-50 volts.	Constant potential circuit 45 volts.	Alternating current circuit 28 volts.
2000	9.6	10	16
1200	6.8	6.5	10
800	4.25	4.0	6.5

Current in Amperes for Enclosed Arc Lamps

Type	Circuit	Current in Amperes	Volts Across Arc.
D.C. Series	Constant Cur't	6.6.	72 to 76
A.C. "	" "	6.6	70 to 74
D.C. Multiple	110 Volt	4.5 to 5.5	76 to 80
D.C. "	" "	2.5 to 3.0	76 to 80
D.C. "	220 "	2.5	150
A.C. "	110 "	6.0	70 to 73

Inventions of Peter Cooper Hewitt.

BY A. P. WILLS, '94.

THE *Hewitt Vapor Lamp.*—The starting point of all the recent inventions of Mr. Hewitt was the mercury vapor lamp, which was first introduced at a demonstration before the American Institute of Electrical Engineers at Columbia University, on April 12, 1901.

The mercury vapor lamp in certain forms was known many years before this. Chief among those who, previous to Mr. Hewitt, have employed mercury vapor carrying on electric current as a light giving device, was Dr. Arons of Berlin, whose important work in this direction was published in 1892. But neither Dr. Arons nor others before Mr. Hewitt succeeded in producing lamps of such design as to give promise of much success under such practical working conditions. It was left to Mr. Hewitt to make the important discovery of what the geometry of a mercury arc-lamp must be in order to furnish a self-regulating device, with commercial possibilities. He early recognized the important role which the density of the vapor plays in the operation of the lamp; and he also showed how the density of the vapor can be controlled.

Figure 1 shows one form of the Hewitt lamp. It consists of a vertical cylindrical tube swelling at the top, In the process of manufacture the lamp is connected to the pump by means of a small tube not shown in the figure. The pumping out process forming the "condensing chamber" which contains the anode, A, (usually of iron): the cathode, B, is usually simply a puddle of mercury at the bottom of the tube.

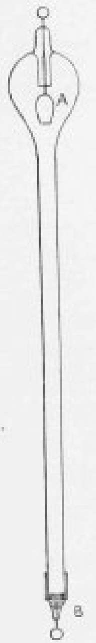


Fig. 1.

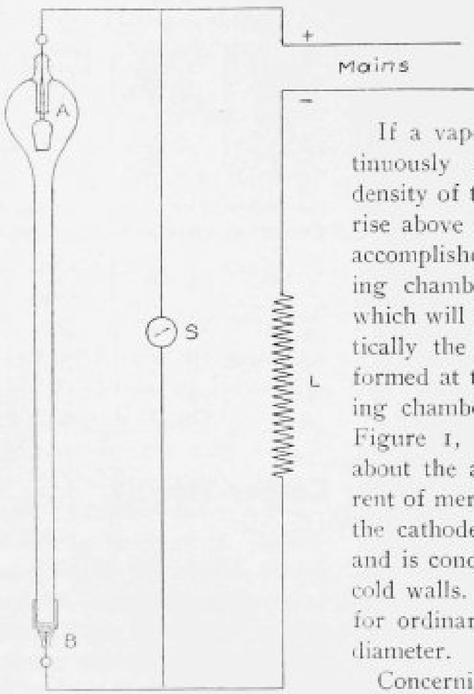


Fig. 2.

is a most thorough one; a chief difficulty here is in getting rid of the gases which exfoliate readily from the iron anode. This is overcome through heating the anode to a white heat while it is acting as the cathode under a high tension discharge. For a considerable time before the lamp is removed from the pump a continuous current sufficient to heat the lamp to a temperature of 200° C or 300° C is sent through it. This causes a steady stream of mercury vapor to flow from B towards A which carries along with it what of air and other gases may still be lingering within the tube. When the lamp is taken from the pump, sealed, and allowed to cool, there is practically nothing within it but mercury vapor under a pressure which is that of saturated mecury vapor at room temperature. Thus is a Hewitt mercury vapor lamp.

If a vapor lamp is to operate continuously it is necessary that the density of the enclosed vapor does not rise above a certain amount. This is accomplished by attaching a condensing chamber, of proper dimensions, which will condense the vapor at practically the same rate at which it is formed at the cathode. The condensing chamber for the lamp shown in Figure 1, is at the top of the tube about the anode; the connection current of mercury vapor ascending from the cathode rushes into this chamber and is condensed on its comparatively cold walls. This condensing chamber for ordinary lamps is about 3 cm. in diameter.

Concerning the operation of the lamp: a considerable difficulty occurs right at the start; for a while a lamp may have no objection to the conduction of a current which has somehow been started, it certainly does have a decided objection to the actual starting. Imagine a vertical pipe containing a column of water supported by a membrane constituting a bottom for the pipe; there is a force acting in the vertical downward direction which is just equal to the weight of the column, and tending to make it fall, and would do so were not the membrane capable of exerting an equal counter-force. Suppose the membrane to be suddenly jabbed with a brad-awl; the water flows now readily enough, although the force downwards acting upon it is the same as before; the resisting counter-force has, at least in part, been removed. In the vapor lamp corresponding to the counter-force of the membrane there is a counter-force of some sort at the cathode which must be banished before the lamp will operate on the difference of potential for which it was designed. (This difference of potential is usually in the neighborhood of one hundred volts.) To accomplish this result, in place of a brad-awl a wave of high potential is employed in a manner which will be evident after a reference to Figure 2. Before the lamp starts, the potential difference between A and B will be that of the mains, and, of course, no current passes from A to B by reason of the counter cathode force at B. Now let the switch S be closed. A current will quickly grow up in the inductance L, with its proper magnetic field about it. Suddenly open the switch and the energy of the magnetic field is suddenly transformed into that for a momentary high tension current in the circuit containing the lamp. This high tension current plays the role of the brad-awl in the analogy, by breaking down the high cathode resistance. The exact nature of this cathode resistance is still very obscure. The all important empirical fact, however, that the momentary high tension current is sufficient to reduce it from thousands of ohms to four or five, is perfectly well established. [It is this fact, coupled with another, namely, that a certain minimum current only is required to prevent this enormous resistance from immediately re-asserting itself, which forms the basis of the more recent inventions of Mr.

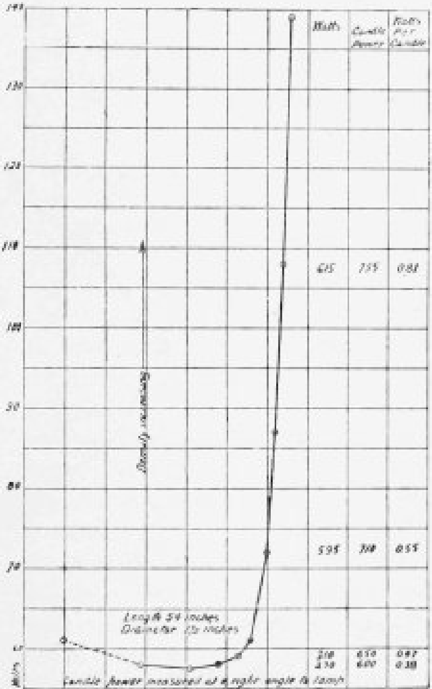


FIG 3

Hewitt.]

A reference to the curve shown in Figure 3 may prove instructive. The curve gives the relation between the drop over a lamp, while operating in a room at about normal temperature, 20 C, and the current. This characteristic curve has a minimum section which can be made very flat by properly assigning the condensing chamber. Along this flat section the current may vary between wide limits and yet cause practically no change in the terminal voltage. Fortunately it is in this self-regulating domain that the efficiency of the lamp is greatest. An idea of the great efficiency of the lamp is obtained by referring to the numbers at the right. When the current gets fairly large the density goes up pretty rapidly and with it the terminal voltage and if there is a limit to the supply of the latter the lamp soon goes out.

normal light. It is rich in actinic rays, however, and very suitable for all kinds of photographic work.

The Hewitt Static Converter.—This device is essentially a Hewitt lamp, and the principle of its action depends upon the cathode resistance mentioned above. Its action can be most easily understood by considering it in connection with a single phase current.

Referring to Figure 4, D is an alternating current dynamo; C, the con-

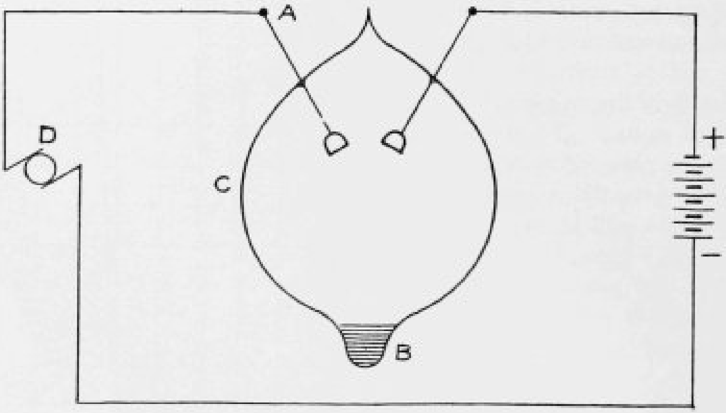


Fig. 4.

Concerning the effect on terminal voltage of varying the length and diameter of the tube: it increases directly with the length and with some inverse power of the diameter, probably not far from the first; more accurate experiments bearing upon this latter point are now in progress.

The great drawback of the Hewitt lamp is the color of the light it emits. It is quite lacking in red rays, and there is, of course, a very noticeable distortion of color values for all objects reflecting these rays under

verter with the mercury electrode at B; F is a battery or other source of direct current suppy capable of giving one or two amperes at about twenty volts. The function of this auxiliary source of supply is to keep down the cathode resistance at B, as explained above. If the E. M. F. characteristic of the alternator be a sine curve, then the current characteristic will consist practically of intermittent half waves which all lie on the same side of the axis of zero current; that is, the characteristic represents an intermittent direct current. The reason of this is clear if one reflects that, with reference to the alternating E. M. F., A and B take turns at being anode and cathode; when A is cathode no current can pass from B to A for the high cathode resistance at A objects; not so, however, when B is playing the cathode role, for then the high cathode resistance is non-existant in virtue of the direct current from F.

The converter may also be operated on currents of higher phase and the auxiliary direct current may then be done away with.

The Hewitt Current Interrupter.—Perhaps the most important of Mr. Hewitt's recent inventions is the current interrupter. This is nothing more than a mercury vapor lamp with two mercury electrodes. This device is designed to replace the ordinary spark-gap over which it has many practical advantages. In the first place the ordinary spark-gap absorbs a considerable amount of energy, and moreover its action is liable to irregularities subject to the conditions of the sparking points or surfaces. These disadvantages disappear upon the substitution of the Hewitt interrupter. It is clear, of course, that the action of the interrupter depends upon the rapid appearance and disappearance of the high cathode resistance in a manner quite analogous to the variation of resistance in the ordinary spark-gap. The Hewitt interrupter seems destined to play a very important role in the future development of wireless telegraphy sending apparatus.

There is another and very important light in which the Hewit vapor lamp may be viewed and this is as an instrument of scientific research. To appreciate the truth of this one has but to reflect that the great advances in physical knowledge today are being made through the study of electric discharge in gases. To mention only one or two of the results of such study; it seems now most probable that inertia itself, that most fundamental property of matter, is in reality an electromagnetic phenomenon; the atom of Hydrogen has been proved to be quite a large bit of matter in comparison with electrons of whose existence we have now quite definite proof; recent work in Germany has shown that an electromagnetic theory of matter is quite within the range of possibility. Maxwell himself long before such results as these were more than dreamed of, strongly emphasized the importance of the study of the behavior of electricity passing though gases. The mercury vapor lamp with its adaptability for use with large currents ought to prove a valuable instrument in furthering the pursuit after facts of the most fundamental importance in connection with modern scientific notions—*The Tufts Engineer.*

Hundreds of electricians are at this moment striving to construct lamps in which nothing is consumed save the electrical energy applied to them—lamps that have the radiance of the sun and the coldness of the moon.

The United States has granted 3,500 patents to women.

Automobile building gives employment to 20,000 persons in France.

STRUCTURAL.

Bridge and Structural Engineering

ASSISTANT PROFESSOR E. H. ROCKWELL.

SINCE the earliest times the human race has expended a vast amount of its energy and thought upon the art of construction. In fact a large part of our knowledge of the past has been preserved to us through the medium of inscriptions wrought with infinite pains upon the walls and pillars of ancient temples. The pyramids of the Egyptians form a wonderful monument to their builders, and the temples of the Greeks have given us ideas of architectural beauty which may never be surpassed.

But the dawn of the nineteenth century brought with it modern problems which the construction of the past could not meet.

Means of transportation must be found which would not only carry traffic across the expanse of plain but which would span the mighty gorge and the rushing flood.

Previous to the nineteenth century, bridges had been built, it is true, both in stones and wood, and many of them are still to be seen; but with the advent of the steam locomotive, the need began to be felt for much larger and stronger bridges. Thus the bolder engineers began to look to iron as a means of accomplishing their ends.

Iron, of course, has always been known, certainly by historic man, yet its production had been too limited and costly to be extensively used in bridge work.

Probably the first iron bridge ever constructed for railway purposes, was built in England in 1823 for the Stockton and Darlington Railway. It consisted of four spans of about twelve feet each, supported in cast iron bents. The top and bottom chords were curved, and were stiffened by vertical cast iron posts, spaced about two feet apart, but there were no inclined web members to resist distortion. Thus there was at this time no conception of the true truss principal, although heavy members and a large factor of safety carried this structure through more than twenty years of active service.

The true principle of truss design depends upon the fact that only one polygon, the triangle, can be subjected to direct stress along its members without causing distortion. For this reason all framed structures should be made up of a combination of triangles.

In America wood was the favorite material, until about 1840, but timber is unreliable in tension, and wrought iron rods were soon adopted for tension members.

The Howe truss, which was a result of this innovation, consisted of wooden top and bottom chords, wooden compression diagonals latticed and abutting against cast iron blocks, with vertical rods in tension. This proved to be a very successful application of iron and many fine examples of Howe railroad and highway bridges are still to be found in the United States, especially in districts where cheap timber has made this construction a matter of economy.

From 1840 till after the Civil War, both cast and wrought iron, were extensively used, the cast iron for compression and the wrought iron for tension.

Wrought iron soon began to displace both wood and cast iron, and by 1875, experience had entirely justified its use for the entire bridge superstructure.

In 1856 the Bessemer process of steel manufacture was invented, and steel soon began to be used. But it was not until 1873, however, that it was adopted throughout in any important structure, when Capt. Eads used it in the great arch bridge across the Mississippi.

Steel is considerably stronger than wrought iron, and as it became cheaper gradually displaced iron, until in 1890 steel was practically the only material used.

The growth of steel manufacture has been rapid. In 1870, only 69,000 tons of steel, all told, were made in the United States; whereas at the present time over 10,000,000 tons are annually manufactured, of which amount, 1,000,000 tons are used for bridge and structural purposes alone. With the possible exception as to durability, steel is an ideal material for structural and bridge construction. It is lighter even than timber for structures of equal strength. It is tough, posesses great strength, and is of such ductility and elasticity that it should always be possible to detect weakness long before actual failure occurs.

Contemporaneously with this development in the manufacture of a suitable material for bridge structures, there occurred a like development in the mathematical principles which govern their design. Up to about 1840 or 1850 experience had been the only guide in the matter of design, for practically nothing was known of its mathematics until 1837, when Squire Whipple, a civil engineer of Utica, N. Y., published a small treatise entitled, "An Essay on Bridge Building." This was quite a profound study of the subject and showed a remarkable familiarity with methods for the determination of stresses and designing of members, ably discussing the questions of moving loads and economic dimensions.

Squire Whipple was far from being a mere theorist for he actually built a large number of bridges, most of which were in the form of what is known as the Whipple truss.

Of course, iron structures had been built previous to Whipple's discovery, and it is interesting to consider one important case, as an illustration of how the mathematical difficulties were overcome.

About 1840, it became necessary to span the Menai Straits, in Wales, with a bridge capable of carrying railroad trains. Robert Stevenson, who was the most eminent engineer of his day in England, became interested in the project and undertook to solve the problem. It was necessary to span about 1,400 feet in all, and it was decided to make two spans of 460 feet and two of 230. Up to this time trussed bridges in the modern sense had not been built and Stevenson conceived the idea of making a huge tube through which the trains could pass.

Of course, nothing was known concerning the economic depth, the amount of material required, or its distribution, but it was decided to make it about thirty feet high, thirteen feet wide and wrought iron plates, angles and tees, were selected for the material.

A model tube was next constructed, one-sixth actual size in every dimension. This was subjected to twenty-five experiments, and as any part failed it was replaced by a stronger piece. At the twenty-fifth experiment it totally collapsed carrying a load of 193,-000 lbs.

The final structure now known as the Britannia Tubular Bridge was designed by means of a formula derived from these experiments, and successfully served its purpose for many years, but was very uneconomical. Only one other important example of this type was ever built, the Victoria Bridge at Montreal, and this was much lighter than its predecessor. Yet the Victoria Bridge cost almost three times as much per foot, ($1,100 and $388 respectively) as the Lachine trussed bridge erected near it in 1888.

At about the time of Whipple's publication, the building of trussed bridges rapidly increased. Many different forms were tried but the law of the survival of the fittest has eliminated all but a few.

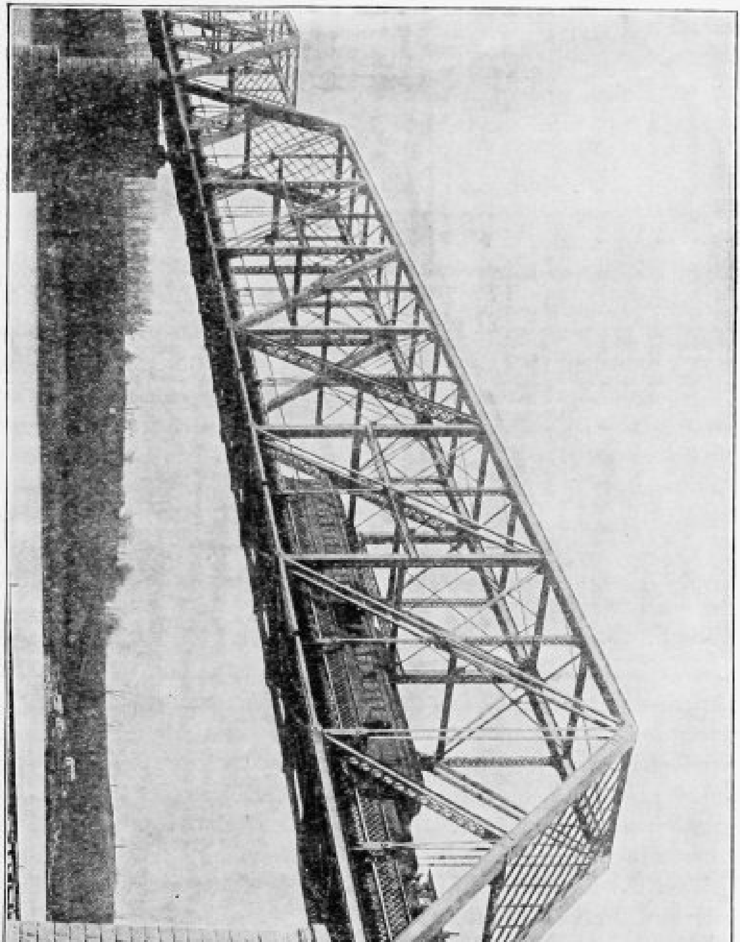
For short spans up to 250 feet, the Pratt and Warren styles have maintained their superiority and are still largely used. They are both trusses with a single system of bracing; the Pratt has vertical compression pieces and inclined tension pieces, while the Warren has both compression and tension pieces inclined.

In bridge work, beams or stringers carry the loads to the floor beams, which in turn carry them to the points of intersection or panel points of the trusses. Now stringers cannot be economically designed longer than twenty or twenty-five feet, and this fact has hitherto limited the panel length of Warren and Pratt trusses to about 25 feet, which in turn limits their economical span to 300 feet at the most. The Whipple truss has a double system of web bracing and with the same panel length as before can be made of twice the span of the Warren or Pratt trusses.

For this reason the Whipple truss has long been a favorite for brdges of span from 300 to 500 feet, and many of the finest examples of American truss work are built in this form, such as the Cairo and Cincinnati bridges, both of which have over 500 foot spans.

The Whipple truss has now been largely superseded by the Baltimore and Petit trusses.

The Baltimore is similar to the Pratt but has short sub-verticals and ties or struts, which makes it possible



Double-track Through Bridge over the Missouri River at Bellefontaine, Mo.

to obtain both the short panel length and the long span. The Petit truss is similar to the Baltimore except it has a curved upper chord approximating the parabola in form, which causes all the top chord stresses to be nearly uniform. The bridge plate shows one span of the double track bridge over the Missouri at Bellefontaine, Mo. The trusses are of the Baltimore type, and although it is not an exceptionally long span, yet it is an excellent illustration of the principle of sub-panelling and gives a clear idea of the latest development in simple truss design.

In 1847 a light highway suspension bridge was erected at Niagara, but soon after, in 1855, this was replaced by the first suspension bridge for railroad traffic. Roebling, the engineer, found that many able English engineers believed his scheme to be not only impracticable, but impossible; yet he proceeded with its construction until success vindicated his judgment and ability.

It is interesting to note the fact that this bridge was several times successfully repaired without interruption of traffic, until scarcely a single piece of the original structure remained.

Traffic rapidly increased, however, and finally after forty years of successful service the suspension bridge was replaced by a steel arch of 550 feet span, again without any interruption of railway traffic, although up to this time, it was the largest arch for railway traffic in the world.

It was built out from the abutments, piece by piece, from each end, until the two parts exactly met at the centre, completely enclosing the old suspension bridge and finally displacing it entirely. Nearer to the falls is the newest of the Niagara bridges, the Clifton arch. This is built for highway traffic only, but it has the distinction of being the longest arch of any kind in existence. There is also another famous bridge near this, the 470 foot Cantilever, erected in 1883, for railroad purposes.

In the words of a noted engineer, "The four great bridges across the Niagara River gorge stand as an epitome of American bridge engineering."

After his successful completion of the Niagara bridge, John Roebling was naturally chosen to direct the design and construction of the great suspension bridge between New York and Brooklyn. This is probably, the most famous engineering work in America, and has indeed been justly regarded as one of the wonders of the world.

The new East River bridge now under construction, will not only eclipse its famous predecessor in span, size and cost, but will possess the greatest load carrying capacity of any sctructure in the world. Two immense steel towers, 1,600 feet apart, and weighing 6,000,000 lbs. each, will rise above the river to a heght of 335 feet. Suspended from these by massive steel cables, there will be 16,000,000 lbs. of steel, hanging over the river in mid air, with an added capacity of 9,000,000 lbs. more of live load.

The ends of the cables are imbedded in masonry anchorages which reach the tremendous amount of 250,000,000 lbs. at each end. Two separate masonry piers are provided for each tower and together carry to the foundations over 100,000,000 lbs. This load is carried down through one hundred feet of water, mud, sand and clay, to the solid rock, by means of gigantic caissons or timber diving bells. These were floated into position and gradually lowered to the required depth. In order to prevent the water from flowing in under the edges, powerful compressors were used to constantly pump air into the working chambers, while great quantities of concrete were deposited in the caissons to keep them down. Large tubes were lowered into the caisson and through these, the mud and smaller stones were rapidly carried up and over the sides, by the tremendous air pressure in the caissons. Thus the men working in the chamber were gradually lowering the whole to solid rock, while others were building masonry on top, causing the foundation to grow in two directions at once.

The Firth of Forth cantilever with two spans of over 1700, feet is the largest bridge in the world, but its ability to carry heavy moving loads is considerably less than that of our new East river suspension bridge.

The English structure also affords a striking illustration of the differences in design and erection, here and abroad.

In America, bridges are usually built in the shop, piece by piece and are riveted together for the first time at their final resting place, where everything goes together like clockwork. In England, on the contrary, the old methods still prevail to a large extent, and in the case before us an entire bridge plant was erected near the site of the bridge, where the separate pieces were built one by one and fitted into place as the progress of the work required. There is also a great difference in appearance. The main members of the Forth bridge are cylindrical tubes, twelve feet in diameter and the large size of these gives the structure an appearance of great strength and massiveness, especially when contrasted with our much lighter appearing work, which is somewhat misleading.

The American design is usually quite as strong, more economical of material, and full as pleasing to the eye.

A recent French work of great interest, the Viaur Viaduct,* is now the largest arched span for railway traffic in the world. being 722 feet between end pins. In general appearance it bears a much closer resemblance to recent American work than anything lately built by either English or German Engineers.

It is indeed very similar to an arch recently designed and built by Theodore Cooper in Porto Rica, but differs from it in the important fact that it has three hinges or points of articulation, one at each abutment and one at the crown. In the Porto Rica bridge the pin at the crown is omitted, which makes it impossible to determine the stresses by the principles of pure statics alone, and requires the use of the elastic theory, enormously increasing the amount of mathematical labor involved.

Theoretically the two hinged arch possesses the advantage of being stiffer and also of being about ten per cent. lighter.

The disadvantages are due to the indeterminate character of the structure, to the large temperature stresses, and to the great care required in erection, especially in providing solid and immovable abutments. In many cases of two hinged arches a movement in the abutments of even a few inches may cause such variation in the stresses as to nullify the value of the original computations.

Neither of the latter objections obtains against the three hinged arch, and many able engineers believe that its theoretical disadvantages disappear when practice is joined to theory.

In other lines of bridge work progress has been in the direction of simplicity, and as the Viaur Viaduct is also a step in this direction, it will be instructive to note how this structure will fulfill the condition of rigidity under heavy railway traffic.

Although the Viaur arch is an apparent exception, yet on the whole, European, and especially German engineers are inclined to use the more complicated and indeterminate structures, involving assumptions and refinements of computation which the actual case would hardly justify; whereas Americans have usually adhered to the simpler and more determinate forms.

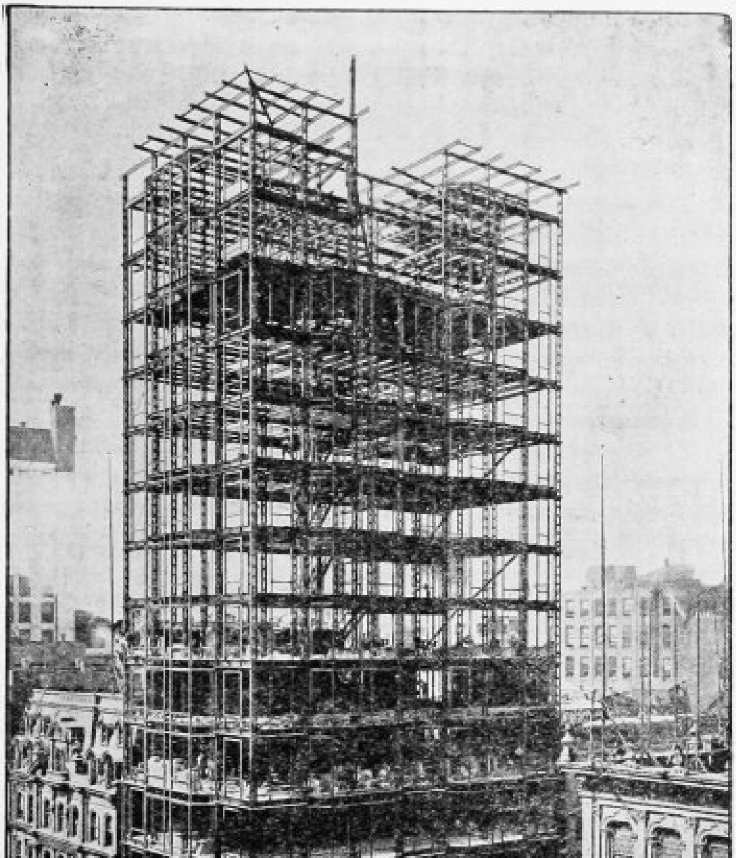
In Europe, on the other hand, engineers have long endeavored to give their structures a fine architectural appearance, while in America until recently, utility and economy have been the predominating considerations. The resulting effect in many cases has been to build structures with a monotonous repetition of straight lines and dull detail, content if only the engineering features of strength and stability are satisfied. It is, however, agreeable to note that we are beginning to offend much less in this particular.

The newer structures of the arch and suspension forms especially, with their light appearance and graceful curves, are quite susceptible of artistic treatment and this is being recognized in practice as well as theory.

The Washington arch in New York, though severe in form and unpretentious in ornament, is a gratifying success in this respect. And here in Boston, there is the new Cambridge and Boston arch, now under construction over the Charles river, which promises to rival in architectural effect the best previous work of its class even in the old world.

When, however, we come to consider cheapness of manufacture and rapidity of construction we find that we have already left all our rivals far in the rear. With about 200,000 miles of railway, there are in the United States about 65,000 bridges. The steadily increasing weight of engines and trains has made necessary constant removal of old bridges and rapid construction of new ones. This has occurred to a much greater extent here than abroad and accounts in large part for our facilities.

Structural and bridge engineering has assumed such large proportions, that great specialized plants with expensive machinery are growing up where improved methods of manufacture are continually being discovered and adopted. In the United States no important bridge shop is



Reliance Building, during Construction.
Aug. 1, 1894.

now without a complete equipment of travelling cranes by means of which heavy masses of material are quickly and easily moved from one spot to another. A recent traveller abroad found in France, and even in England and Germany to a lesser extent that "handling was done entirely by main strength and awkwardness."

Here, the engineering department including the drafting room, is considered the brain of the establishment. When a great piece of work is under way, the future must be discounted. Every contingency must be foreseen and provided for. Not a piece is made until the drawings for it are complete. Every separate piece has its own number and the position of the number on the drawing indicates where and how this unit shall become a part of the completed structure. When the engineering department has finished a given set of designs, drawings, construction and stock lists, it is safe to say that the amount of thinking required of the workman in the shop has been reduced to a minimum.

Sizes and shapes of material and even details are standardized. Every engineer of experience understands shop practice and consequently new work does not usually exhibit any strikingly strange or awkward construction. Thus it is that the engineers and builders are working together harmoniously with successful results as to economy and rapidity.

European engineers are not, as a rule, in touch with shop methods. In England, at least, according to "Engineering," "it has been the custom for each engineer to design his own bridges with the main object of making them somewhat different from every other engineer's design." The result is obvious.

Considerable amounts of bridge and structural exports have been made from this country within a few years and, as an illustration of what modern American methods are able to accomplish in competition with English conservatism, it may be instructive to mention one or two recent contracts let to American concerns.

The Atbara bridge, Africa, was let to the Pencoyd Steel Co.; 622 tons at $53 per ton; erection in fourteen weeks. English bid $79 per ton; erection thirty weeks. The Gokteik Viaduct, India, was let to the Penn. Steel Co.; 2260 feet long, 320 feet high; 4322 tons at $75 per ton; erection one year, English bid $106; erection three years. The Uganda Viaduct, 7000 tons was let to the American Bridge Co. at $90 per ton; erection forty-six weeks. English bid $108 per ton; erection in one hundred and thirty weeks.

A discussion of this subject would be incomplete without some mention being made of that important branch known as architectural engineering.

It is difficult to say when steel was first used in building construction but a very interesting structure known as the Bank of the State of N. Y. Building, erected about 1855, has been recently torn down.

In this building, the entire floor framing was made of wrought iron. This was before the advent of rolled sections, and the plates were made of plates and bars riveted together in approximately the same form as the present I beam. Aside from the interesting methods used in overcoming difficulties of framing, this work, uncovered in the spring of this year, affords valuable testimony as to the durability of steel in building construction. After forty-eight years of service the metal was found in almost perfect condition and the names of the builders could be read in the original paint put on in the shop.

This is only one of several buildings recently demolished and as in this case the iron has usually been found in a good state of preservation.

Portland cement and concrete have been found to be almost perfect preservatives of steel, either from moisture or fire, and little fear need be felt when these materials are used to cover the metal.

In general it may be said that the preservation of metal depends upon our meeting the special conditions of each case, and the conditions are such that we are usually able to meet them by using proper care and foresight.

In the earliest examples when iron was used in buildings the floors were carried by iron beams to the walls, and the walls in turn carried their weight, and their own, to the foundation. At a later period interior columns were introduced but, based on false ideas of strength and economy, were usually made of cast-iron. Steel columns have now superseded cast iron ones, in large buildings, at least, and skeleton construction has been largely adopted for important office buildings.

Skeleton construction implies the use of steel as the sole supporting material where the floors, partitions and walls, even, are all supported on the metal frame. The adoption of this method is due to its great saving in floor space. Formerly, high and massive buildings required heavy masonry walls, often ten or fifteen feet thick, which very materially reduced the rentable floor space, especially in the lower stories. In skeleton construction the walls need not be over twelve or eighteen inches.

In localities where the soil is soft, wet, and full of quicksand, as in Chicago, steel is also used for foundations in the shape of large rafters of steel beams imbedded in concrete. In Chicago the soil is so soft that the first story is usually started nine or ten inches above its intended elevation so that the full load of the completed building will bring it to the proper level. This fact necessitates very careful designing in order to have the foundation areas proportional to their loads. This fact was lost sight of in the Old Post Office building, and an actual settlement of twenty-four inches at one point eventually caused its abandonment. One of the plates represents a typical skeleton frame before the walls were built in, and was taken from a photograph of the Reliance Building, Chicago, during erection in 1894.

In closing we find that Bridge and Structural Engineering has reached a condition of comparative completeness during the preceding sixty years. There are but few problems that the modern engineer cannot readily solve, and almost no service that steel in some form will not perform.

Experience has shown that plate girders are the most serviceable for railway traffic up to about 100 spans.

Pratt and Warren trusses, are the best for spans from 100 to 250 feet and Baltimore and Petit trusses the most economical from 250 feet to about 500 feet. Arches and cantilevers have decided advantages in many cases of peculiar difficulties, cantilevers being economical in spans from 500 feet to 1200 feet, while suspension bridges are probably the best under ordinary conditions for spans over that amount.

Simple and determinate forms of trussing have survived in the kinds mentioned; while complicated and indeterminate forms have disappeared.

In architectural engineering we have created vast buildings which tower hundreds of feet in the air and safely and economically house thousands of business men and women on small areas of ground.

Evolution of form and the survival of the fittest will undoubtedly continue to work important changes, yet it can almost be said that engineers are awaiting the discovery of a newer and better material than steel in order to show any great or startling changes.—*"The Tufts Engineer."*

Railway Construction.

The operation of the suction dredges used by the government in river and harbor work is very interesting. A long, flexible tube 12 to 15 inches in diameter drops down from the side of the vessel 20 to 30 feet or more to the bottom of the river or harbor upon which the dredging is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump, making several hundred revolutions a minute and capable of handling many hundred tons of water an hour. The lower end of the tube is manipulated from the vessel against the sandbars and mud banks, and as the water is sucked upward by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pumps discharge this water with its suspended material into the tanks on board the vessel or into scows, where the heavy matter quickly settles to the bottom, the water flowing back into the sea.

Suction Dredges.

In 1857 an American named Collins first proposed a railway from the Amur to the village of Tchita. Later, several plans were formulated, but it was not until March 17, 1891, that the Trans-Siberian railroad was definitely determined on and projected by an imperial order. On May 19, 1891, the first stone was laid. The line covers 3,562 miles in Russian territory and 1,604 miles in Chinese territory. In ten and one-half years 5,166 miles of rails were laid. In the Canadian Pacific, constructed under similar conditions, it took ten years to lay 2,921 miles of rails.

Lorain, O.—The B. & O. is completing one of the most inexpensive and unique coal loaders on the lakes. At a high place along the river bank the coal will be dumped onto an endless belt, which will convey it into the boats. It will also be one of the quickest loading plants.

ILLUSTRATING.

Descriptive Designs of Wall Paneling.

Ancient and Modern Decoration in Art.

BY CHARLES C. RIESTER.

THE ancient Egyptians—Egypt, the land of wisdom—Egypt of all other nations seemed to have designed and planned decorative art of wall antiquities to the best available models of strength.

Their design was rather in the permanence of construction, than for an artistic point in decoration. They used the most exclusive regard for the strength of their creative designs. There was a dim, bewildered instinct, a yearning of immortality always manifested in all their undertakings. They preferred for the art an unconscious existence in the form of hideous mummies to utter dissolution. They feared that the bodyless spirit might lose its personal idea, and expected or wished, after the expiration of the great cycle, to find all their great deeds, just as they had left it, exactly so without change, without decadence—the same bodies in their design and strength, the great obelisks pointing at the stars, their great pyramids and sepulchers; a strange faith, that they thought the soul after all varieties of an untried being should return into one of these strange and prehistoric idols and mummies to animate them. The Nile itself could tell a wondrous tale regarding these reminiscences of priest crafts and the mummeries of a perished creed.

From Egypt we have but to turn a page and we have the Greek, the Gre-

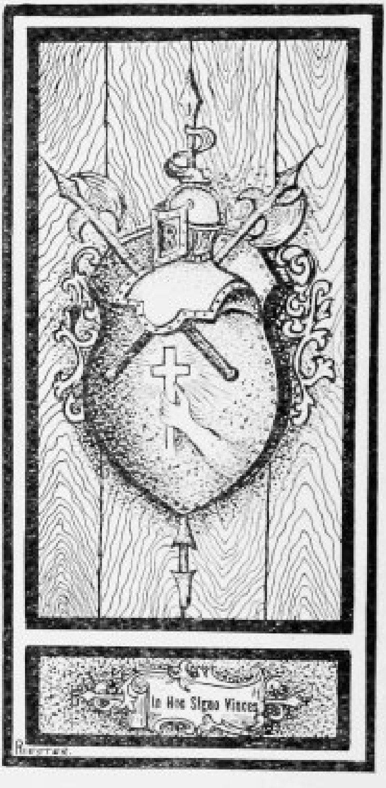
Ancient Greek Figure.

cians so different, yet a slight similarity to that of Egypt. They in all their art and design only worked for the beauty, and where beauty always predominated, the classic Greek is the ideal, from whence all beauty springs is a reality, so fair their forms, so neat their arrangements, so colossal their magnificent columns, and all in all, we have Greek as the master of all art and science. Their exquisite imaginative creations were the outlines of fairness, forms such as Venus and Apollo were common to the Grecian citizens. Expression and character were their chief aims in all their arts. Characteristic portrayals of pain, joy, sentiment and thought were visible in their work.

In my illustration of ancient Greece I have tried to convey a dim recollection of the Grecian greatness in art. You will see an ideal woman in all her beauty, as only Greeks loved to see woman, her whole expression denoted one of beauty, languidly poised, so as to enrich her exquisite features. They were numerous in all the homes of the classic Greek. Great pillars and fountains marked the interior of these dwellings. We, in our time only are imitators of the art and design which predominated and beautified all ancient Greece, Egypt and Rome.

The Romans merely imitated the Greeks, their masters in all arts. The unimportant changes they undertook to make cannot be said to be improvements.

After describing the decorative art of the Greeks, I pass on to the middle ages, when heraldry sprung into its use. In the eleventh century the use of heraldry was installed for decoration of wall panels. Heraldry consisted of armor, shields, helmet, battle axes and lances used by the leader of the crusades, and devices which marked noted leaders on the field of battle. The different possessions of the warriors were valued by their followers as being in so close a connection with his personality that they used them for wall decoration in every conceivable form. This lasted from the eleventh



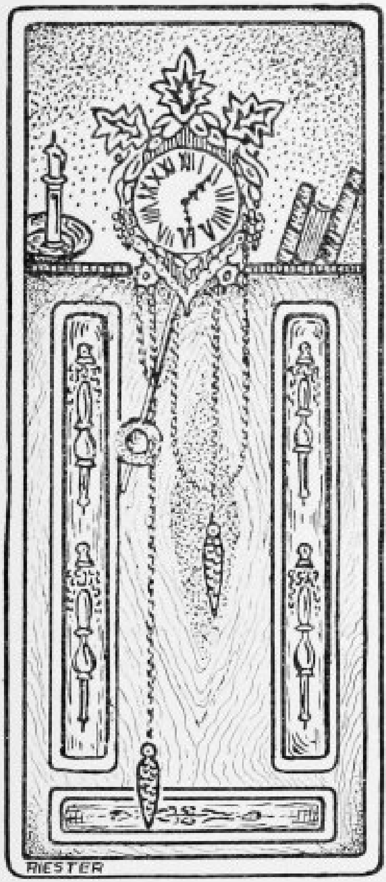
Heraldry in the 11th Century.

century until the middle of the sixteenth century. During this time the use of heraldry was greatly developed with a high standard of artistic panel and wall decoration, certain changes have been made until the strength of heraldry came to a close in the sixteenth century.

The illustration presented herewith

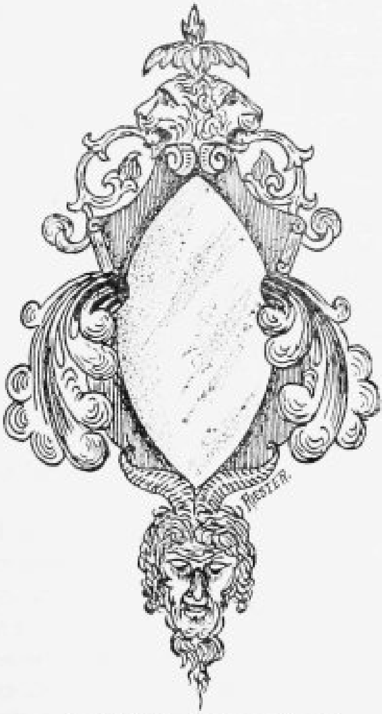
is an example of the style which was greatly used in those changeable times. Very unique and would certainly be a good decorative design for use in one of our modern "dens."

You will note the battle axes crossed under the helmet which is



The Colonial of our Forefathers.

hung on the face of the shield; the center of the shield has the emblem of the crusades, the cross being their mascot on one side. When the great religious strife was being waged: under the shield on a small panel you will see the inscription which is in Latin, "*In Hoc Signo Vinces,*" which means, "*In this sign thou shall conquer.*" You will note my pen sketch the lance, which is in the background, on which there is a remnant of the color borne by the warrior. The draftsman who may make use of heraldry for decorative purposes will do well to study the different styles and



A Modern Antique Panel.

suits of armor, some times armor cloth, as may be the period.

Now we will proceed with some of the modern designs used. All the artistic decoration in wall panel design is, I may say, a mere repetition of the old, but before going farther on in our modern design, we turn to the colonial times of our forefathers. Nothing seems more homelike to us as the old surroundings, so simple in its simplicity, say a long common oak board with a few oblong panels carved at a convenient height, and an old Swiss clock, on each side a small shelf is constructed. To the left of the illustration you will see an old brass candle stick, on the right a few books, while perhaps in front of the fireplace, a neat woman humming a sweet song and rocking the infant into its peaceful sleep, while her hands are deftly spinning the flax on the old spinning wheel; but enough, and in place of sentiment I will make a few notes regarding our designs.

Then in the illustration entitled Modern Antique Panels, often used in ballrooms, halls, reception rooms, etc. The design is partially like those of the Greek, the scrolls and lion heads, the characteristic head at the bottom is also taken from the old style of decorations. In the center is placed an oval shaped mirror; the mirror should not be too high.

In speaking of our modern design, it is of little use to say more regarding the illustration I here present.

In the February issue of THE DRAFTSMAN I have remarked the use of different flowers, leaves, acorns and grape designs that can be worked in wall paneling and decorative art.

In the illustration marked slight suggestions for panel design you will see carnations entwined with a sort of a hook stipple for the background. Then you will see the oak leaves and

Suggestions for Panel Designs.

acorns with a st ipple of dots for the background, the grapes and leaves made so as to work in a scroll-like appearance is very neat. The student may take any leaf, or more so, anything in nature's botanical gardens, you do not have to wish for any material, you have the whole world to choose from.

HOME STUDY.

Trigonometry Simplefied.

BY J. S. MYERS.

MANY persons when reading The Draftsman or other kindred technical matter find therein formulæ containing the abbreviations, Sin., Cos., Tan., etc. To one initiated they are no mystery, but, alas, far too many skim over these, saying to themselves, "Oh, that's trigonometry! It's too technical for me. I don't understand higher mathematics." This particular division of mathematics is, in fact, quite easy to grasp, even by the very ordinary mind. The writer has known boys in the drawing room to pick up in half a day the nucleus of the entire subject, which is merely the solution of a triangle. When one can do this he is able to successfully cope with most any problem arising in machine design or structural details.

It is not necessary to remember a myriad of formulæ about "side opposite" and "side adjacent." There is a simpler and easier method. Any one who can multiply and divide can solve practical problems in trigonometry.

There are six values to be known in every triangle, three angles and three sides. If any three of the values be known, one or more of these three known ones being a side, the other three can be determined. If all the three angles be known the relative proportion of the sides can be readily calculated. This is what is termed solving the triangle, and is nothing more or less in practice than simple proportion.

Take a triangle A, Fig. 1, and one B, Fig. 1, exactly like it, only larger. It is seen at once the sides C and D are twice as long as the similar sides on A; for if the side E be twice as long as the corresponding side on A, all the other sides are twice as long as there are corresponding sides on A.

Then $C = 2 \times 1.25 = 2.5''$ and $D = 2 \times 1.9 = 3.8''$. If this side E had been, say 6.3″ instead of 2″, then C would have been $6.3 \times 1.25 = 7.875$ inches, and side D would have been $6.3 \times 1.9 = 11.97''$.

In trigonometry we simply have tables giving the lengths of two of the sides when the other side is equal to 1, worked out for all angles from zero to 90°, and all we need to do is multiply to find the length of a side not known, or divide a known side by the side which equals 1 in the tables, and by referring back see what angle this quotient corresponds to.

These tables are worked out for triangles having one corner square, or equal to 90, i. e., they are right-angled-triangles. One side which may be considered the radius is equal to 1, the other two sides are named. All that is then required is a sketch showing which side equals 1 and the names of the other two sides when they can readily be found in the tables by name.

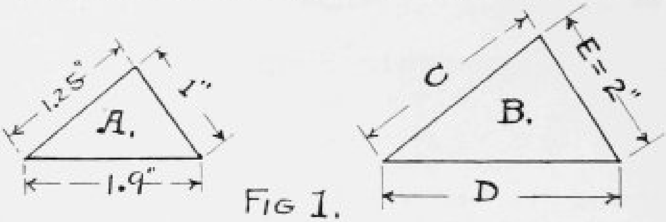


FIG 1.

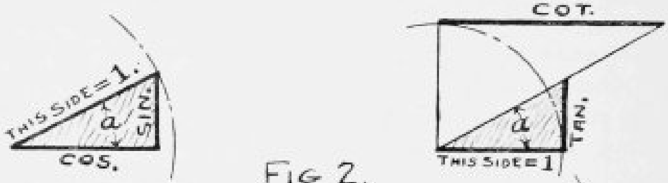


FIG 2.

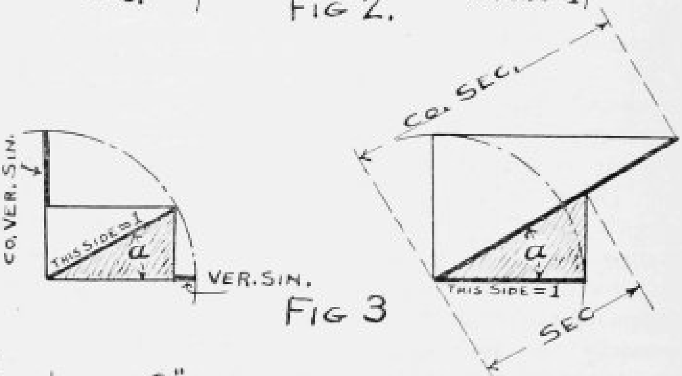


FIG 3

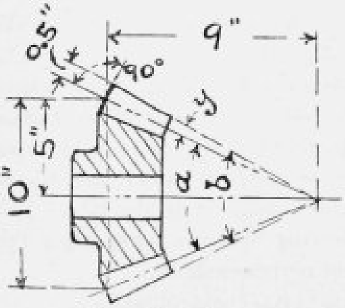


FIG.4 a

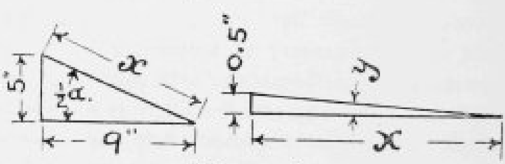


FIG. 4

Fig. 2 shows this for the usual tables with their abbreviations.

Sin. is read Sine;

Cos. is read Cosine;

Tan. is read Tangent;

Cot. is read Cotangent.

These values taken collectively are called *functions*. The above four are sufficient to solve any triangle, but some tables give additional values, which are convenient at times, especially since it is easier to multiply than divide. Fig. 3 shows these with their usual abbreviations.

Ver. Sin. is read Verse Sine;

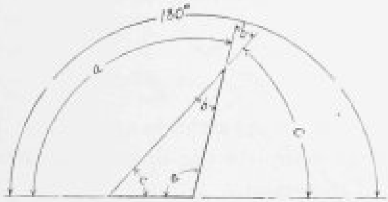
Co. Ver. Sin. is read Coverse Sine;

Sec. is Secant;

Co. Sec. is read Cosecant.

Since the tables are all for right-angled-triangles, one must always divide a triangle into right-angled-triangles for solution.

One more principal and we are enabled to solve most any ordinary problem in practice, which is, that the sum of the three angles in any triangle are equal to 180°. Any one can easily prove this to his own satisfaction by laying out several triangles of various forms and measuring the angles with a protractor, or, better still, by refer-



ence to Fig. 5. The truth of this statement is made so apparent that it needs no explanation.

By the use of this principle, when two angles are known, the value of the third can readily be found by subtracting the sum of the two known angles from 180.

Now for a practical problem:

A bevel gear 10 pitch dia. 2 diametral pitch meshes with another gear 18″ pitch dia. Fig. 4a. What is the pitch angle and the face angle for turning the blank?

First find the pitch angle. We have the triangle A, Fig. 4, 9″ base, 5″ altitude. Referring to Fig. 2, the 5″ side is seen to correspond to the side there named "tangent" when the 9″ side=1. If the 9″ side were 1, the 5″ side to be 1-9 of what it now is or 1-9 of 5=5 ÷9=.5556, referring to a table of tangents this is found to be nearly the tangent of 29 degrees. The pitch angle a is then 2×29=58 degrees.

To get the face angle 6, find the angle y and add twice its value to the pitch angle. To get this angle we must first find the distance X. By referring to Fig. 3, it is seen this line corresponds to the secant, and multiplying the secant of 29 degrees by 9 gives the length X at once. In the absence of a table of secants we find that in Fig. 2 when this line is 1, the 9″ line is the cosine and is given in the table as 0.87462 for this angle. Dividing 9 by 0.87462, we get X, 9÷0.87462 =10.29″ nearly. This side X corresponds to the side which equals 1 in Fig. 2, and the side which is 0.5″ corresponds to the side named "tangent." Dividing 0.5 by 10.29 gives the tangent of the angle y. 0.5÷10.29= .0487 nearly. Referring to our tables we find that this is nearly the tangent of 2 degrees—50′. The face angle is then 2×(2 degrees—50′)+58 degrees —63 degrees—40′ which is the angle for turning the blank.

A novel watch in Zurich is in the form of a ball which moves imperceptibly down an inclined plane without rolling. There is no spring, the sliding giving motion to the hands, and the trip from top to bottom of the inclined surface, a distance of sixteen inches, requires twenty-four hours. The ball is then lifted again to the top.

Hexagon Bolt Heads in Isometric.

O make a hexagon bolt head or nut, we take hexagon stock, square up the ends and chamfer off the corners; having, as a result, what is shown in Fig. 1. Bearing these facts in mind, it may be clearly seen that the first step in finding the isometric of bolt heads is to draw the hexagonal prism in isometric.

In Fig. 2 are shown two views of a hexagonal prism across corners. Draw the diagonal A D and connect the points C E and B F. On examination, it will be found that H D and A G are equal to one-fourth of A D.

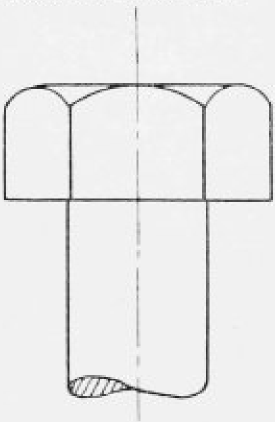


Fig. 1.

To draw the hexagonal prism in isometric, first draw the line A' D', Fig. 3, at an angle of 30 degrees with the horizontal, and divide it into four equal parts as shown. Through G' and H' draw the 30 degree lines B' F' and C' E' equal in length respectively to the lines B F and C E in Fig. 2, and making C' H' equal H' E' and B' G' equal G' F'. Connecting the points A' B' C' D' E' F' A', we have the isometric of the base of the prism.

Drawing vertical lines through the vertices of this hexagon and laying off

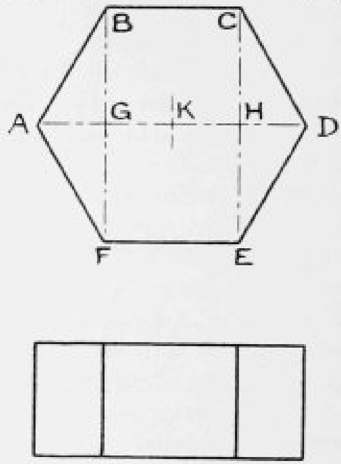


Fig. 2.

on these lines the altitude of the prism, we may complete the isometric drawing of the prism.

In Fig. 4 is shown this same prism

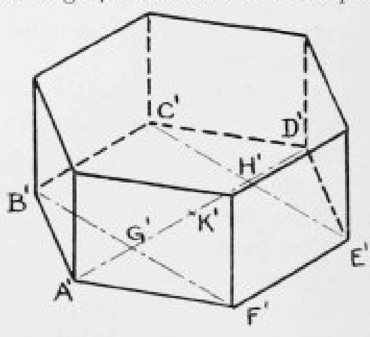


Fig. 3.

with the corners chamfered off, thus forming the hexagonal bolt head. To draw the isometric of this object, proceed as before only laying off on the vertical lines the lengths of the lateral edges of the bolt head. See Fig. 5.

To produce the curves in isometric, proceed in the following manner:

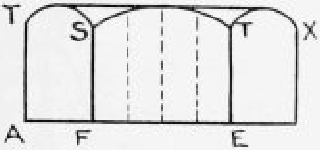


Fig. 4.

The surface S F T E is the true shape of all the lateral faces of the bolt head, and from this one all of the curves may be drawn. Divide the line F E, Fig. 4, into any number of equal parts, dividing the line F' E', Fig. 5, into the same number of equal parts. Draw vertical lines through these points of division. Lay off on the

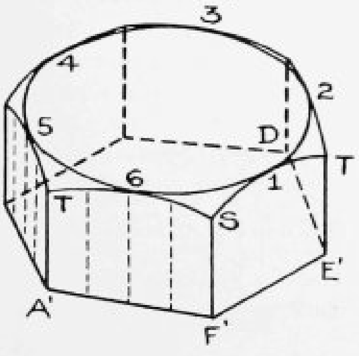


Fig. 5.

lines in Fig. 5, the lengths of corresponding lines of Fig. 4, and sketch the curve through these points. In a similar manner, the curves may be obtained on the remaining five surfaces of the head.

The isometric of the circle caused by chamfering the corners may, if the bolt head be small, be sketched tangent to the points 1, 2, 3, 4, 5 and 6. See Fig. 5.

If the circle be large and it is nec-

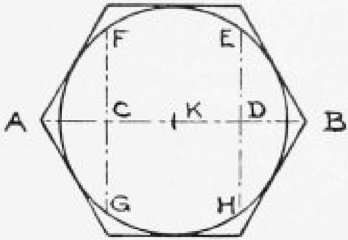


Fig. 6.

essary to obtain more than the six points already referred to, draw the top view as shown in Fig. 6, and divide the horizontal line A B into any number of equal parts. In Fig. 6 the line A B was divided into four equal parts, and the lines E H and F G were drawn.

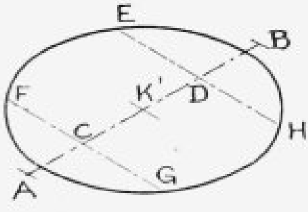


Fig. 7.

Making K' B' and A' K', Fig. 7, equal in length to K B and A K, Fig. 6, and dividing into the same number of equal parts, we may obtain the points E, H, G, and F by laying off the distances from A' B' equal to those in Fig. 6. More points may be obtained by using more divisions of the line A B.

In all of the explanation thus far, we have considered that three of the lateral faces were visible in the ortho-

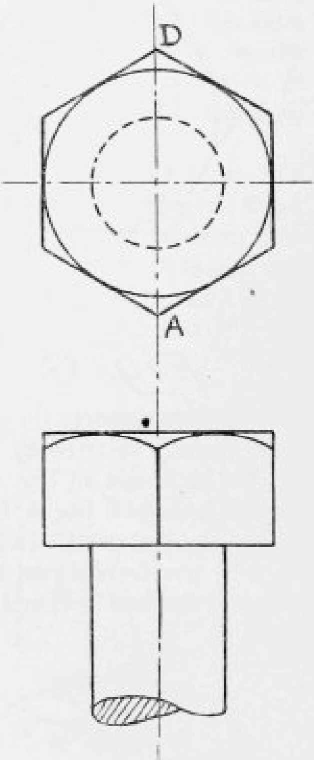


Fig. 8

graphic drawing. If the position of the bolt head was as shown in Fig. 8, the principle is the same, although the

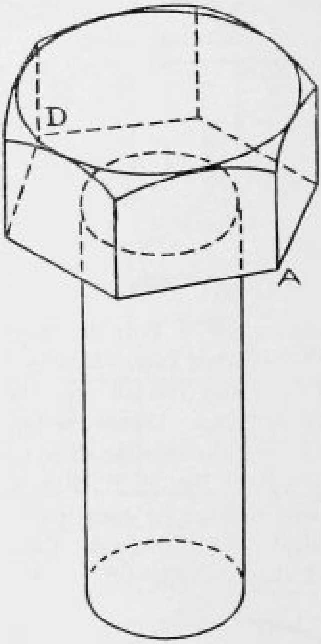


Fig. 9.

center line, A D, will occupy the position shown in Fig. 9, instead of the position A D, Fig. 5.

Arthur B. Babbitt,
Hartford High School,
Hartford, Conn.

Elementary Mechanical Drawing.

DEVELOPMENT OF SURFACES.

TO DEVELOP the surface of any given object is to make a diagram on some thin material, which, being cut out and bent or rolled into the proper shape, will inclose a space exactly equal and similar to that occupied by the given object.

The development of an object is thus a pattern, and all objects of sheet metal, from the simplest tin dish to the most complicated sheet-iron work in pipes, ventilators, boats, etc., are obtanied by means of such patterns.

When the form developed is to be

constructed of paper or sheet metal the outer edges of the development should be provided with projecting pieces called laps, by which the different parts may be held together.

In practical work, sheets of metal cut to the form of the development of the surfaces will shrink some when being bent and rolled into shape, so that a small allowance must be made for this defect.

In boiler and sheet metal work the amount of shinkage is considered to be about three times the thickness of the plate, but in this course we will neglect both the allowance for shrinkage and the laps.

These developments are often called "patterns," or "templates," and the workmen who make a business of laying out such diagrams are called "templet makers," or "layers out."

These workmen take the drawing of the object and develop it upon the material to be used, locating all holes and making allowance for laps and shrinkage.

In practice, the shape of the objects varies considerably, and often the surfaces are intersected by surface of a different shape, so that a further consideration of intersecting surfaces will be taken up with "development," or "pattern drafting."

The following plates take up a few plain and intersected surfaces, and show the manner of development.

PLATE XIV. Problem 1.

To develop the surface of a cube which measures 1½" on all edges.

Draw a plan of four sides which have their edges parallel, and attach them to each other, making a strip equal in length to the perimiter of the cube. Then to one of the faces so developed attach the two remaining faces. Place S 1" from the left and 2½" from the top border line.

Problem 2.

To develop the surface of a portion of a cone, the object being shown in Fig. 2, and the development in Fig. 3.

Since we are dealing with the surface of the cone, the slant height 1-3 is the radius of the development, 1′—3′ and 1—2 is the length for 1′—2′.

The length of the arc, 3′—4′ is equal to the circumference of the base circle and may be laid out with the dividers by stepping around on a circle of the size of the cone base, then laying off the same number of steps on 3′—4′.

Attach the base circle, "B," and top circle, "T," to the development of the surface. Locate 1′, 1" from top and 3½" from right border lines.

The cone is 3½" high, base 2½" in diameter and is located about 8" from the right border line, the base 3—4 being 5" from the top border line and 1—2 is one-half of 1—3.

Problem 3.

Lay out the development of a part of a pyramid as shown in Fig. 4. The circle of the base of the pyramid is 3" in diameter with A placed 2½" from the left and 6" from the bottom border line.

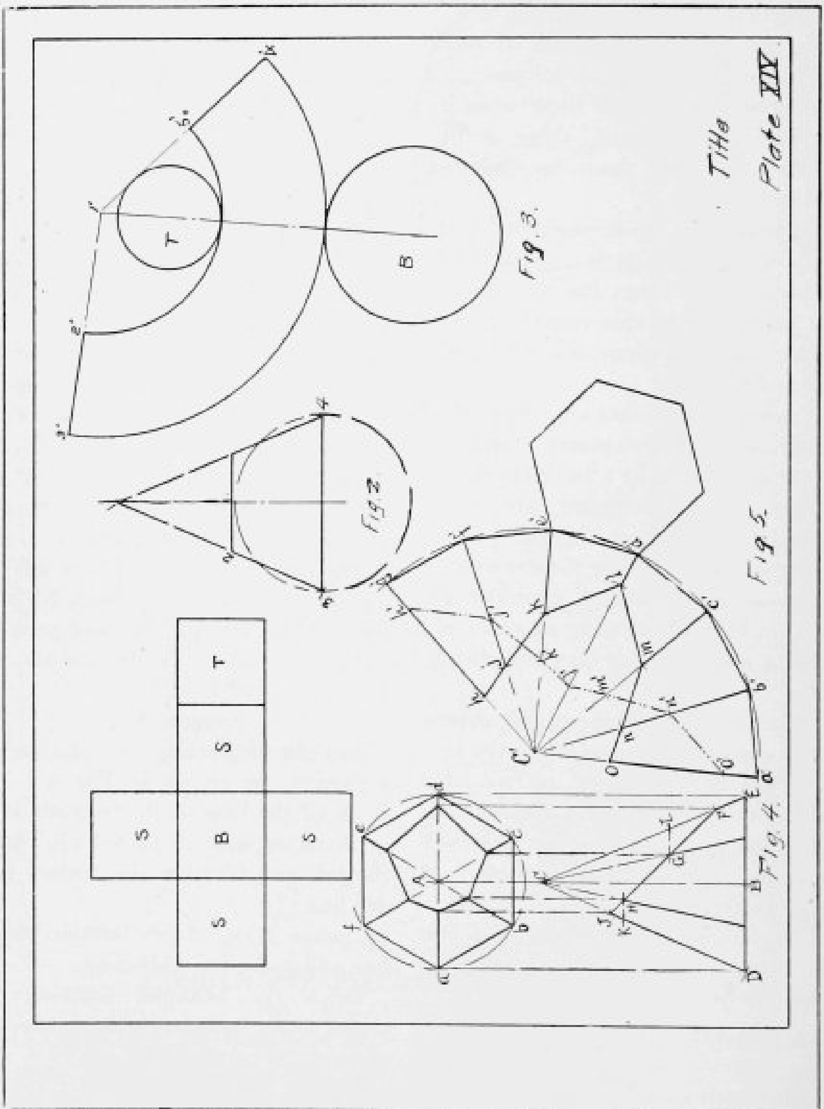
Locate B ¾" from bottom border line and make BC 3½" long.

Draw the hexagon showing the shape of the base in the top view and connect the corners with center A.

Project the points b and c to line DE and draw in the edges of the pyramid.

Draw line JF at an angle of 45 degrees, making EF ¼".

Locate C′ 4¾″ from left border and 4¼″ from bottom border line, and as in the case of the cone, Fig. 2, C′ a′ is equal to the *slant* height CD and is the radius for the development in Fig. 5.



Step off on arc a′ d′ g′ the lengths of the sides of the base, ab, bc, cd, etc., and draw in a′ C′ b′ C′, etc.

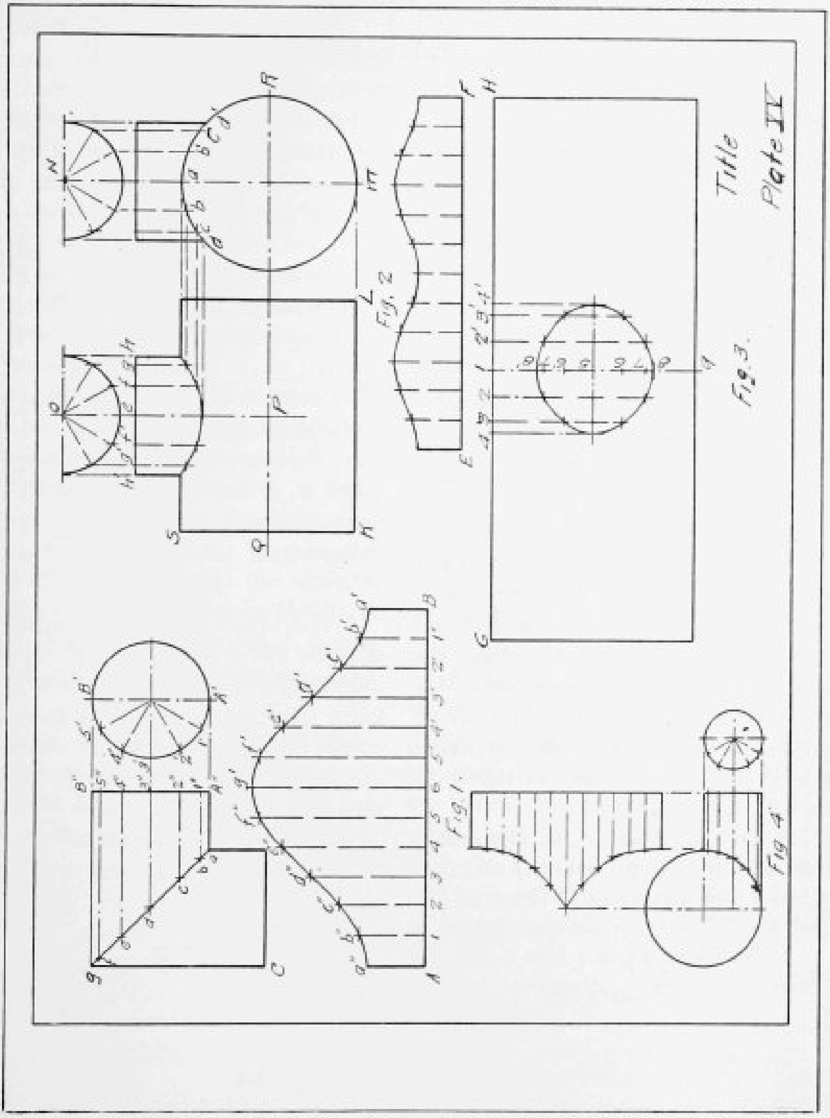
On C′ a′ lay off CJ and on C′ b′ lay off CK, which is CH projected to line CD. Then the heavy line figures a′ o n m e k j h g f′ e′ d′ c′ b′ a is the development of the surfaces of the pyramid, and the base may be attached.

The development may be reversed, laying off a′ o′ equal to EF, b′ n′ equal to EL, and so on, which would produce the figure bounded by the dot and dash line.

If the student put in the form as shown by the dot and dash line, he may have space for the shape of the upper face of the pyramid and this will be left to him to lay out.

(The circumference of a circle is equal to the diameter multiplied by 3.1416.)

PLATE XV. Problem I.



Develop the surface of one part of an elbow whose diameter is 2″. C g and B″ g are each 3″ and are each 1″ from the border, the line ga making an angle of 45 degrees with Cg.

Locate the center line d 3′ and draw the circle on line A′ B′, 1½″ from A″ B″.

Divide the semi-circle into an even number of parts and project point 1′ to A″B″ and draw 1″ b, and proceed the same with the other points.

Lay out the line AB equal to the circumference of circle A′B′ and divide it into the same number of parts as the circle. Then erect lines at these points and make Aa″=A″a, 1b″=1″b and so on until each element of the cylinder is laid out. Through the points a″, b″, c″, etc., draw a line with the aid of the French curve. Then the figure AB a′ g′ a″ is the pattern for both pieces of the elbow.

Problem 2.

Lay out the patterns for two cylinders of different sizes which intersect at right angles. The large one is 3″ in diameter and the small one is 2″ and extends 2″ above the center line of the large one. On the center lines MN and OP, draw semi-circles and divide them into the same number of parts, projecting the points vertically as shown.

Lay out EF equal to the circumference of the small cylinder and find points for the curve as in Prob. 1.

Lay out the rectangle G=HIJ with GH equal to the circumference of circle m Ra and GJ=KL, the length, which is 4″.

Line MN is 2½″ from the right border line and OR is 4″ from the top border.

From 1, the center point of GH, lay out 1—2, and 1—2″ equal to ab and ab′ and 2—3 and 2′—3′ equal to bc and b′c′ and 3—4 and 3′—4′ each equal to cd and c′d′ respectively. Also from the center of 1—9, lay off 5—6 and 5—6′ equal to ef and ef′, and 6—7 and 6′—7′ each equal to fg and f′ g′ and 7—8 and 7′—8′ equal to gh and g′h′ respectively.

Project from points 8, —7, —6, —5, —6′, —7′ and 8′ to lines from 1, 2, 3, 4 and 2′, 3′ and 4′ as shown and draw in the curve, which completes the developments.

Problem 3.

A 2″ cylinder set 2″ from the left border line has a cylinder of 1″ diameter intersecting it as shown. The side cylinder is 2″ long measured from the center of the large one and the center of the large one is 1½″ above the bottom border line.

The manner of laying out the pattern for the small cylinder is the same as in previous problems.

(To be continued.)

CURRENT TOPICS.

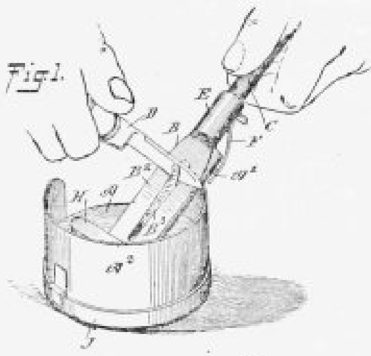
Device for Sharpening Pencils.

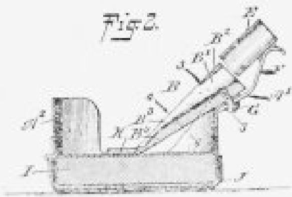
A device for use in sharpening pencils has been invented by Walter S. Doe, of Jersey City, N. J., which is simple and arranged to permit the use of the ordinary knife to cut down the wood and core of the pencil.

Fig. 1 is a perspective view of the device, while Fig. 2 is a sectional elevation, both views illustrating the manner of use quite well.

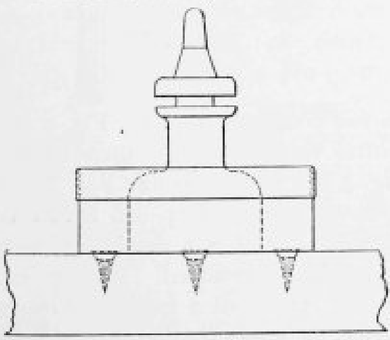
In the illustration it will be seen that the knife would probably strike the base of the cup, but a stop plate, H, made of lead or hard wood, is provided to avoid injury to the blade.

In order to enable the user of the device to readily sharpen the knife, a whetstone, I, is provided in the base, A, so that by opening the cap, J, it may be used and then covered again. The base of the device is covered with felt, so as not to mar the table.





The accompanying sketch illustrates an effective and satisfactory method of dealing with the draftsman's most contrary servant—the ink



bottle. To your table or drawing-board screw an ordinary threaded-top tin box which is just the hight, or, better, a fraction lower than the body of the bottle; cut a hole in the top just large enough to force the neck through, assemble as shown and you will have an inkstand not only able to withstand tipping and sudden knocks, but which will always be found in its place when needed.—*R. C. in American Machinist.*

If THE DRAFTSMAN is as much better as it looks in its new coat of colors, it cannot fail to fill its chosen field to the absolute and complete satisfaction of all concerned.—*Book and News Dealer.*

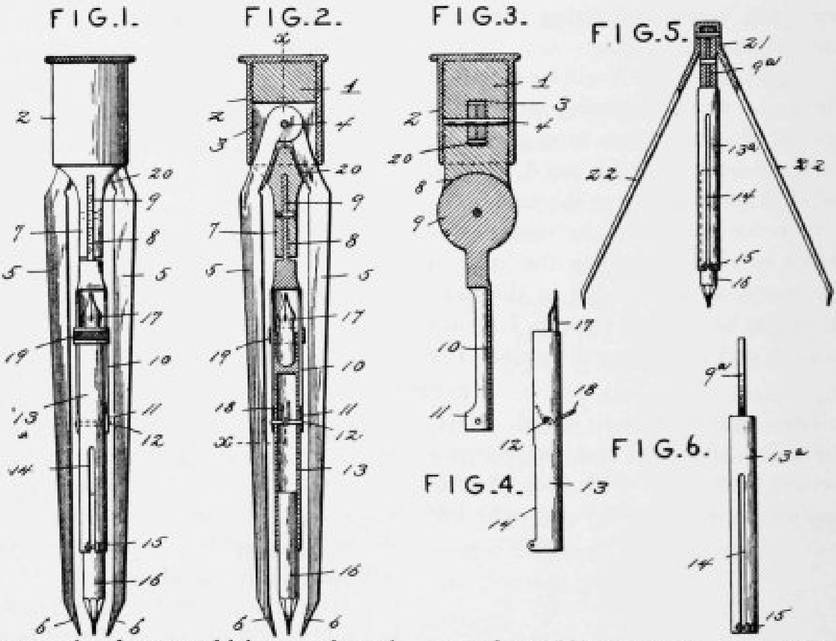
Combination Tool.

THIS invention relates to a new and useful combination-tool adapted to be used by draftsmen for bisecting, drawing parallel lines, laying off angles, measuring distances, etc.; and its object is to provide a simple and compact device of inexpensive construction which may be readily employed for any of the purposes enumerated.

The invention consists in providing a head within which are pivoted the inner ends of arms which are adapted to be used as dividers, compasses, etc., and the head is provided at a point between these arms with an extension having a slot therein, within which is secured a revolable disk having an arm projecting therefrom. A sleeve is pivotally mounted within this arm and is adapted to contain a pencil at one end and a pen-point at the other. The disk before referred to is provided with suitable graduations upon the periphery thereof, whereby the arm of the disk may be turned at any desired angle.

The invention also consists in the further novel construction and combination of parts, which will be more fully hereinafter described, and illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of the improved combination-tool. Fig. 2 is a central vertical section therethrough. Fig. 3 is a section on line *x x*, Fig. 2, with the pen and pencil holder removed. Fig. 4 is a detailed view of said holder detached. Fig 5 is a similar view of a modified form of device, the upper portion thereof being shown in section; and Fig. 6 is an elevation of a modified form of holder.



Referring to the figures by numerals of reference, 1 is a cylindrical head having its outer face threaded and adapted to project into a cap, 2. A slot, 3, extends into the head from the inner face thereof, and pivoted upon a point, 4, in the center of this slot are the inner ends of arms, 5, having straight edges and terminating at their outer ends in pointed extensions, 6, projecting inward toward each other. An extension, 7, is formed at the inner end of the head, 1, and is arranged between the arms, 5, before referred to. This extension has a slot, 8, therein arranged in a plane at right angles to slot 3, and within this slot is pivotally mounted a disk, 9, having graduations upon the periphery thereof. This disk has an arm, 10, projecting therefrom and substantially U-shaped in cross-section, and ears, 11, project laterally from the end of the arms and are adapted to form bearings for the ends of a pin, 12, which project from opposite sides of a sleeve, 13. This sleeve has a longitudinally-extending slot, 14, in one end, and a clamping-screw, 15, is adapted to bind the slotted portion of the sleeve upon a pencil, 16, or other device which may be inserted thereinto. The opposite end of sleeve, 13, is adapted to contain a pen-point, 17.

A spring, 18, is arranged within sleeve, 13, and coiled upon pin, 12. One end of this spring bears upon the inner surface of the sleeve, while the opposite end extends through the sleeve and is adapted to bear upon the inner surface of arm, 10. This spring is adapted to force outward that end of the sleeve, 13, which contains the pen-point, and when it is desired to hold the sleeve in alignment with arm, 10, a ferrule, 19, must be slid longitudinally upon arm, 10, and over the inner end of sleeve, 13, as clearly illustrated in Figs. 1 and 2. A bow-spring, 20, is arranged within slot 3 and adapted to bear upon the inner edges of the arms, 5. This spring will force the arms outward when the cap, 2, is screwed upward upon head, 1. It is obvious that the arms, 5, will be automatically extended any desired distance from each other in proportion to the distance the cap, 2, is removed from the inner end of head, 1. The straight edges of these arms can be used as rulers. The graduations upon one side of disk, 9, are preferably so arranged as to indicate degrees, while those upon the opposite side of the disk indicate inches and fractions thereof. With this arrangement, therefore, the arm, 10, and the sleeve connected therewith can be moved any desired distance from the plane within which the arms, 5, are located, and this distance will be promptly indicated in inches upon the periphery of disk 9. The degrees of a circle can also be obtained in the same manner by referring to the graduations upon the opposite side of the disk. As the arm, 10, swings in a plane at right angles to the planes of arms 5, it will be understood that the same are always at equal distances from the two arms. With this device, therefore, the center of a circle can always be quickly and accurately located.

In Fig. 5 is shown a modified form of instrument which may be employed where it is deemed unnecessary to have both a pen and pencil for marking purposes. By referring to this figure it will be seen that the sleeve, 13, has the central portion of a spring-strip, 21, riveted to the opposite sides of the ends thereof, forming a head, and the ends of this strip from spring-arms, 22, which are the equivalent of the arms 5, before referred to. The disk 9a is mounted within the end of this modified form and has a tubular extension, 13a, integral therewith for the reception of a pen, pencil, or other marking device. This form of instrument is adapted to be used in the manner described in connection with the device shown in Figs. 1, 2, and 3; but instead of employing a cap to adjust the spring-arms it is necessary to press them inward by hand. The disk and tubular extension, 9a and 13a, are illustrated in detail in Fig. 6, and, if desired, the graduations shown in Fig. 1 may be omitted from disk 9a. as shown in Fig. 6.

The inventor is Mr. Clyde R. Jeffords, Ithaca, N. Y.

Solar Energy.

All the energy of life is derived ultimately from the sun. A little of this comes indirectly through lightning, which, in passing through the air, forms ammonia and oxides of nitrogen. These, being carried by rain into the ground, are the constant source of nitrogen for vegetable, and, indirectly, for animal life. A much larger quantity of energy is well known to be taken direct from the sunshine by plants and used in their anabolic processes. This energy is appropriated by animals in their food, and whether in the vegetable or in the animal it assists in many alternations of the system before it is completely dispersed.

New Aid to Navigation.

In the ship-warning system of Mr. C. E. Kelway, signals by Hertzian waves are sent out from the lighthouse at regular intervals, at the same times as the sound warnings. A vessel in range having a receiver notes the time that passes between receiving the wireless signal and the sound warning, and is thus enabled to calculate its distance from the lighthouse; and on repeating the observation after continuing a few miles, data is obtained for ascertaining the exact location of the lighthouse by trigonometry. A stop watch reading directly in distances and a special position finder have been devised for use with the system.

Japanese Workman.

(Continued from page 97)

nation in all things, but at the same time the Japanese buildings, grounds, exhibits, etc., will inevitably possess a vivid local color of exceptional attractiveness,

From the attitude of the Japanese draftsman would lead one to think that their drawings would be much on the free hand order, though it is known that there have been hundreds of young men educated in this country to use American methods in that class of work.

Worlds Fair Pointers.

Polo will be a feature of World's Fair games.

Illinois will make a complete fish exhibit at the World's Fair.

Chattanooga, Tenn., will erect a $25,000 building at the World's Fair.

Germany and America will have competitive exhibits of forestry, each five acres in extent, at the St. Louis World's Fair.

A rose garden six acres in area and containing 50,000 rose trees, will be one of the attractions at the St. Louis World's Fair.

A model farm, representing a section of land 160 acres in extent will be one of the interesting and valuable exhibits at the World's Fair.

The leading painters and sculptors of St. Petersburg, Russia, have promised to co-operate in organizing a Russian art exhibit at the St. Louis Exposition.

The State of Maine Building at the St. Louis World's Fair will be unique in character, its motif being the log cabin, the walls constructed entirely of logs.

New Mexico will make an exhibit of turquoise mining at the World's Fair. A lapidary showing how the stones are cut and polished and prepared for the market will be a feature.

The British National Pavilion at the World's Fair, St. Louis, will be a reproduction of the orangery or banquet hall of the Kensington Palace, in Kensington Gardens, London.

The chief feature of the Cornell University exhibit at the St. Louis Exposition will be a plaster model, eight by six feet, of the campus. This will show the streets, buildings, gorges and waterfalls, all in color.

According to W. Kohlsaat, Commissioner of the Exposition to Norway, Sweden and Denmark, the Crown Prince of Sweden will attend the Fair, and his intimate friend, Crown Prince Frederick, may also come.

Curious Properties of Radium.

The properties of radium are extremely curious. This body emits great intensity all of the different rays that are produced in a vacuum tube. The radiation, measured by means of an electroscope, is at least a million times more powerful than that from an equal quantity of uranium. A charged electroscope placed at a distance of several meters can be discharged by a few centigrams of a radium salt. One can also discharge an electroscope through a screen of glass or lead five or six centimeters thick. Photographic plates placed in the vicinity of radium are almost instantly affected if no screen intercepts the rays; with screens, the action is slower, but it still takes place through very thick ones if the exposure is sufficiently long. Radium can therefore be used in the production of radiographs.—*Century.*

Not Drafting Instruments.

A pair of deviders.

Size of Panama.

Panama is not nearly so small as it looks on the map. The Carribean coast line is 450 miles long, and the bay of Panama is 110 miles long and 122 miles across at its mouth. The entire republic is twice the size of Switzerland.

"A San Francisco man says there are three kinds of flying machines."

"Well, what the public is waiting for is the fourth kind—the kind that will fly."—*Cleveland Plain Dealer.*

An elephant's jaw has been unearthed in Halleck canyon, Wyoming.

Thirteen new theaters, to cost $8,000,000, are building in New York city.

Animals have a language made up of signs or inarticulate sounds expressing impressions, sensations, passions, but never ideas. So this language excludes conversation and is limited to interjections or signs of movements expressing joy, grief, fear, anger, all the passions of the senses, but never more.

Unusual Sequel,

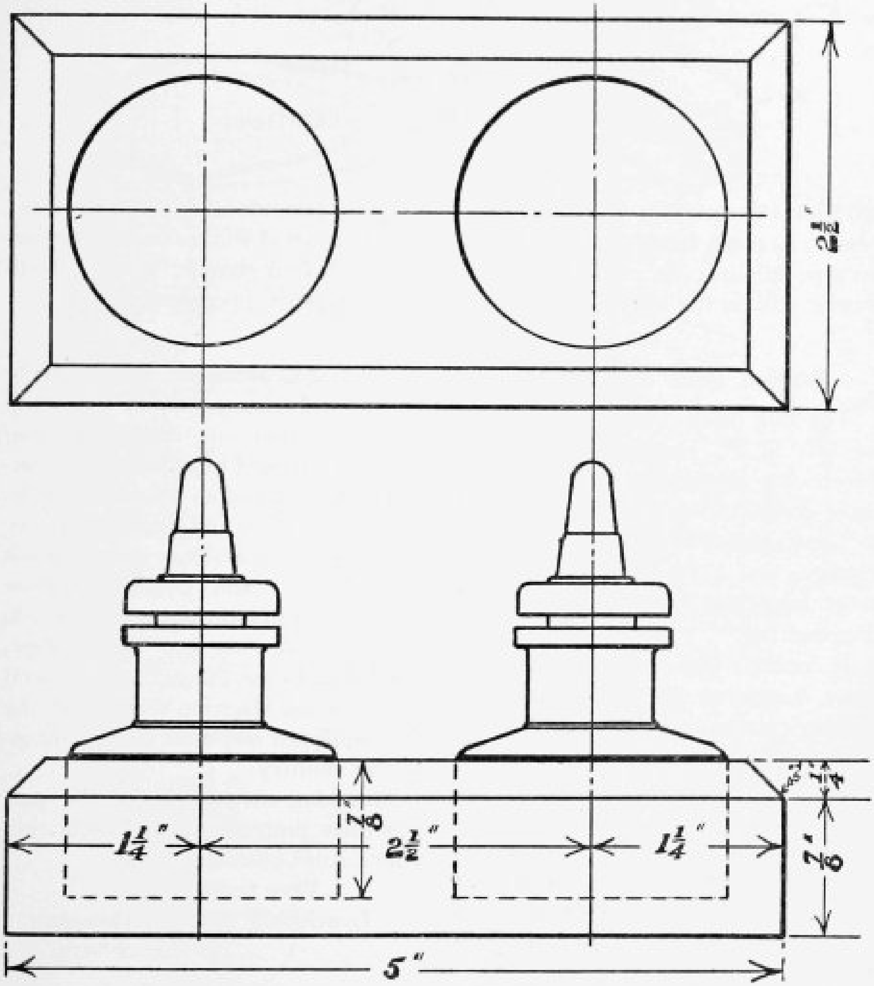
We came upon the inventor who was interested in sky navigation.

"Hello, old man," we greeted, "are you still working on that airship?"

"No," he sighed, limping away on his crutches. "I dropped out of it."—*Chicago Daily Mail.*

Double Bottle Holder.

A hard wood block of these dimensions will make a convenient holder fo bottles of ink of two colors.

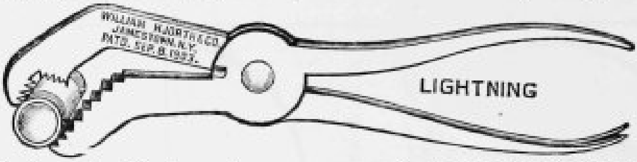


A New Paper Product.

Waste paper is used as the basis of a new composition which is said to be hardier than many kinds of stone. The secret is that of a Yonkers (N. Y.) man, who has given it the name of pollardite. As a thin veneer placed on iron, wood, stone or brick, it is said to offer protection against fire, water, acids or rust, resisting the effects of extremes of high and low temperatures. It is composed chiefly of waste paper pulped and molded into form, and presents the appearance of stone in color and consistency.

Combination Wrench and Plier.

This Wrench is a perfect Pipe and Nut Wrench combined. It takes pipe without crushing and is always ready without adjustment. It is not neccessary to mash handles while in use on pipe or nuts, as pressure on one handle will do the work. It has slso a Wire Cutter, Screw Driver and Nail or Tack Puller.



Made of drop forged tool steel, properly tempered, highly polished an put up in good workmanship manner.

Made in four sizes by Wm. H. Jorth and Company, Jamestown, N. Y.

Books and Pamplets.

The long delayed authorized edition of Mr. S. P. Thompson's Dynamo-Electricity Machinery is by far the most complete work of the kind, and in latest editions embraces all the great changes that have taken place in this most important branch of Electrical Engineering.

It contains 996 pages, 573 illustrations, 4 colored plates, and 32 large folding plates, and the authorized American edition is published only by Spon & Chamberlain, 123 Liberty St., New York.

For the benefit of the student and young designer especially, a few facts and formulæ have been compiled in a booklet form on the subject of "Pulleys."

This contains information on speeds, belts, rims, arms, hubs and keys, and some remarks on fly-wheels, and is arranged in the order here named. It is printed on coated book paper, 6 x 9 in. pages, with 27 illustrations and several tables. Price, 25c. Address The Draftsman, Cleveland, Ohio.

We beg to announce to our many friends and customers, and the trade generally, that our corporate name has been changed to Lynchburg Foundry Company and as successor to the Lynchburg Plow and Foundry Co., we will continue operating the McWane Pipe Works, and Lynchburg Plow Works, manufacturing a high grade of Cast Iron Gas and Water Pipe, Chilled and Cast Plows, and General Foundry and Machine Work, with the best equipped and most modern plants in this country.

Thanking our friends for the past generous pattronage, and soliciting your future business, we are,

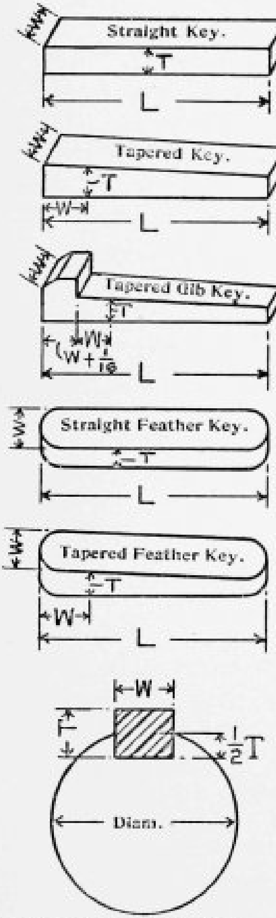
Very truly yours,

Lynchburg Foundry Company,

Lynchburg, Va.

For high-grade work requiring precision and excellence there is to be found in nearly every machine shop in Germany a group of American tools—a silent tribute to the remarkable position held in the world to-day by the American machine tool's work.

Some Good Proportions for Keys.



Taper of Keys 1/8" in 12"

Diam.	W	T	Diam.	W	T
1/2"	1/4"	3/16"	3 1/4"	7/8"	3/4"
5/8	1/4	3/16	3 3/8	7/8	3/4
3/4	5/16	1/4	3 1/2	7/8	3/4
7/8	5/16	1/4	3 5/8	1	7/8
1	3/8	5/16	3 3/4	1	7/8
1 1/8	3/8	5/16	3 7/8	1	7/8
1 1/4	3/8	5/16	4	1 1/8	1
1 3/8	7/16	3/8	4 1/4	1 1/8	1
1 1/2	7/16	3/8	4 1/2	1 1/8	1
1 5/8	7/16	3/8	4 3/4	1 1/8	1
1 3/4	1/2	7/16	5	1 1/4	1
1 7/8	1/2	7/16	5 1/4	1 1/4	1
2	1/2	7/16	5 1/2	1 3/8	1 1/8
2 1/8	5/8	1/2	5 3/4	1 3/8	1 1/8
2 1/4	5/8	1/2	6	1 3/8	1 1/8
2 3/8	5/8	1/2	6 1/2	1 1/2	1 1/4
2 1/2	11/16	9/16	7	1 5/8	1 3/8
2 5/8	11/16	9/16	7 1/2	1 3/4	1 3/8
2 3/4	11/16	9/16	8	1 7/8	1 1/2
2 7/8	3/4	5/8	8 1/2	2	1 1/2
3	3/4	5/8	9	2 1/4	1 5/8
3 1/8	3/4	5/8	10		

An Arrow on Key indicates direction in which key is driven into Hub.
An Arrow on detail indicates direction in which Hub is driven on to key.
For intermediate Diameters of shafts take key for next smaller shaft.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study,

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Can Ships be Rendered Unsinkable?

BY FRANK C. PERKINS.

ALL of the large steamers of modern construction are divided into watertight compartments by bulkheads. These bulkheads have to be pierced with openings in order to work the ship, passages being provided for the officers, firemen, engineers and passengers. These openings are fitted with watertight doors and, in case of danger, orders are issued for closing these bulkhead doors, rendering each compartment watertight and secure.

Should anything prevent the closing of the bulkhead doors the entire equipment of the ship's hull, with watertight compartments, would be of no use, and there is a large list of disasters arising from the failure to close these openings.

The accompanying illustration, Fig. 1, shows the hydraulic accumulators, and drawing, Fig. 2, shows the apparatus of the Stone-Lloyd system for closing all of the doors in a ship in a few seconds, either collectively or

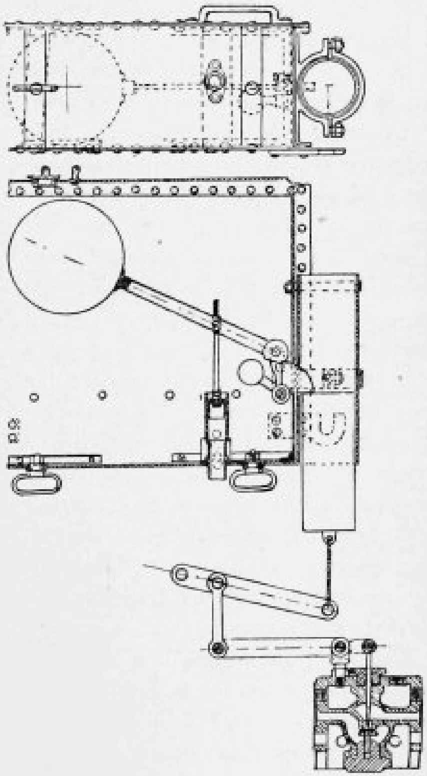


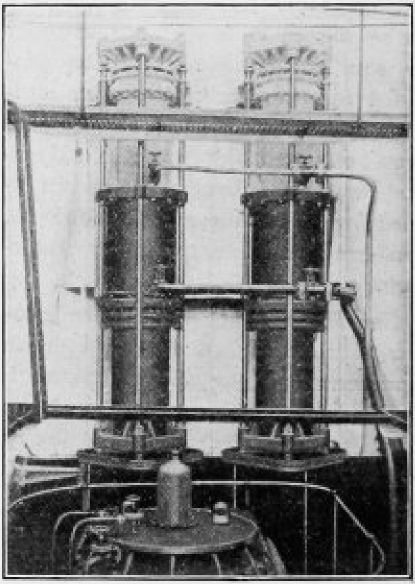
Fig. 1 and Fig. 2.

individually, from the captain's bridge, or any other convenient point. This English system also provides that should this precaution be neglected at the captain's bridge or elsewhere by those in charge, the entrance of water into any one or more compartments would automatically close the bulkhead doors in those compartments. The illustration and drawings show the apparatus as fitted in the imperial mail steamer "Deutschland" of the Hamburg-American line.

It is claimed that the failure of bulkhead doors has arisen in the past in almost every case from the length of time required to effect the closing at the critical moment. In the past the doors have had to be closed mostly by hand and individually. This hydraulic system for closing bulkhead doors which is claimed to render ships unsinkable was installed on the "Deutschland" and the "Kaiser Wilhelm II," as noted in the drawings, Figs. 2 and 4, by J. Stone & Co., of Deptford, London, England.

A warning bell sounds before the door commences to descend, and as the door descends very gradually it can be stopped, raised or lowered by means of a lever placed close to it on both sides of the bulkhead. It will thus be seen that there is no danger of anyone finding himself trapped in a flooded compartment.

The doors are closed at a regulated speed under pressure which is sufficiently powerful to cut through three or four feet of coal; but it is said it is not so dangerous or ineffective as when the allowing the doors to fall by their own weight. The "Deutschland" has twenty-four watertight doors and pressure is supplied to all of the doors by a pressure-main running the whole length of the ship, and this main is in communication with four steam hydraulic accumulators, as shown in Fig. 1. They have a sufficient capacity when fully charged to supply a pressure of six hundred pounds per square inch, to close all of the doors, and even if the pumps should be stopped they are capable of opening and closing a group of eight doors. A duplex long stroke slow speed hydraulic pressure pump has been provided for charging the accumulators and pressure main, the pump being capable of supplying pressure to close all of the doors without the



accumulators in ten seconds.

A five hundred gallon tank has been installed from which the hydraulic pump draws, all of this apparatus being located above the water line. From the pressure main a branch rises to the bridge, and by means of a distribution box the pressure can be turned into either of the two smaller pilot mains which run the whole length of the ship. One of these pilot mains is used for operating the controlling valve at each door for opening the same and the other for closing it. An hydraulic differential cylinder is arranged at each door of an area sufficient to close the door with a force of one, two or more tons, as desired.

In case of a collision it is possible for the officer in charge on the bridge to sound warning bells throughout the ship by simply moving a lever, which at the same time releases the action which starts the closing of all the bulkhead doors, the latter being effectively closed in a very short time. In case anyone should be shut in a compartment, it is possible to open the door on either side by moving the lever provided for the purpose, and the door closes automatically behind them so that it is impossible for the door to remain open.

In case the officer in charge should fail to close the bulkheads the in-rush of water would close the doors of that compartment automatically, and an automatic indicator shows on the bridge the exact position of every door, so that the officer in charge can always know whether any particular door is closed or open.

The accompanying diagram, Fig. 3, shows the arrangement of a small well near the door arranged with a lever and a hollow brass ball. The ball is raised as the water enters the well, and the lever is moved so that it releases the weight, operating a valve on the hydraulic main, and in this way automatically closing the bulkhead door. The exhaust main runs the whole length of the ship under the floor plates. It exhausts into a 200-gallon tank in the engine room and a small auxiliary pump discharges it into the 500-gallon supply tank above the water line. The auxiliary pump is also available for pumping at high pressure into the hydraulic main. By using three parts of water and one part of glycerine for the pressure fluid freezing is prevented and the consequent bursting of pipes while it also acts as lubricant to the bearing surfaces and a preservative to the packings, leathers and joints.

In the event of an accident to the mechanism of the system, all of the doors close automatically. The hydraulic cylinder drives the door shaft by means of powerful spur gear, bevel wheels being used in connection with a hand gear on the upper platform. The handle with quadrant is duplicated on the other side of the bulkhead and operates the controlling valve on the upper platform by steel wire cords.

At the present time the motive power which might be employed for opening and closing the bulkhead and other doors on ships includes steam, electricity, compressed air and hydraulics. Many engineers hold that steam power should not be employed for closing bulkhead doors on account of the danger of scalding, while others claim that electricity should not be employed on account of damage to wires, interruption of current by melting of fuses and for economical reasons. Those engineers favoring hydraulic methods claim the compressed air pumps are more expensive, while hydraulic power is more reliable, is cheaper, safer and more advantageous than any other which can be used. It is interesting to note an extract from the official Admiralty Minute on the loss of H. M. battleship "Victoria."

"Before the collision took place, a large number of watertight doors, hatches and ports were open and that owing to the inrush of water many of these, situated in the forward part of the ship, could not afterwards be closed. Many compartments must therefore have been flooded in addition to those which were actually breached by the collision."

"The question remains, What would probably have happened if all doors, hatches, etc., had been closed in the 'Victoria' before the collision took place? Investigation shows that while the loss of buoyancy must in the case have been considerable, yet making all due allowance for probable damage, the ship would have remained afloat, and under control, and able to make port under her own steam. Her bow would have been depressed about to water level; her heel to starboard would have been about one-half of that observed before the lurch began; her battery ports would have been several feet above water, and she would have retained ample stability."

It will be noted from the above that a reliable system for closing bulkhead doors had it been in successful operation on the "Victoria," whether operated by steam, electricity, compressed air or hydraulic power, would have saved this English battleship together with her officers and crew. Whether ships may be rendered absolutely unsinkable is a question difficult to determine with certainty, but there is every reason to believe that a reliable system for controlling the doors of the airtight compartments is practically the only method of providing against the sinking of ships in case of collision or other accident where the ship's hull is punctured.

MECHANICAL.

Power Transmission by Belting.

BY CARL H. BEACH.

When power is generated at one point to be used somewhere else at a greater or less distance the question, how may it be transferred with the greatest economy and safety, always arises. Economy of time, money and space and safety to life and property. It would not be wise to attempt the transmission of power over a distance of 500 or 1,000 feet by leather belting which would not only be expensive to install and operate, but would be very bulky. There are, however, instances where wire ropes have been used to transmit power over very long distances, as, for example, cable street railways, which were so common a few years ago. No one method of power transmission will meet the requirements of all cases, and in many, if not most instances, no one method alone will accomplish the desired results so a combination of two or more are employed.

When a fixed speed ratio is not imperative some form of belting is usually most satisfactory. It is flexible, cheap to install and keep in repair when the span is not too great and the belt is not exposed to heat, moisture or oil.

Leather belting is composed of strips of leather riveted, glued or sewed together to form a continuous band of the required length; the width depending upon the amount of power to be transmitted and some other conditions which will be discussed further on.

Belting might be treated mathematically to obtain the amount of power that it can reasonably be expected to transmit, but the formulæ thus obtained are cumbersome and contain such unknowns:

f—the co-efficient of friction which varies from .15 to 1.35;

T_1—the tension on the driving side;

T_2—that on the following side, both of which may vary from little more than the weight of the belt to 1,000 or 1,500 pounds per square inch of belt section.

To obviate the difficulty thus arising it is quite customary to use one or another of the many empirical formulæ, a few of which together with other data are taken from Prof. Kent's Mechanical Engineers' Pocket Book, pages 877 to 887.

Let d=diameter of pulley in inches; rd=circumference; V=velocity of belt in feet per second; v in feet per minute; a=angle of the arc of contact;

L=length of the arc of contact in

feet;

F=tractive force per square inch of sectional area of belt;

w=width of belt in inches;

t=belt thickness;

S=tractive force per inch of width $=\frac{F}{t}$

r. p. m.=revolutions per minute;

r. p. s.=revolutions per second$\times \frac{\text{r. p. m.}}{60}$

The production of 33,000 foot-pounds of work in a minute constitutes a horse-power, hence:

$$HP=\frac{S\ v\ w}{33000}=\frac{S\ V\ w\times 60}{33000}=\frac{S\ V\ w}{550}\ (a)$$

But as

$$V=\frac{\pi d\ r.p.m.}{12\times 60}=.004363\ d.r.p.m=\frac{d.\ r.p.m.}{229.2};$$

we obtain by substitution in (a);

H. P.=.000007933 Sdwx r. p. m. (b)

When F=275. and t=7-32, S=60 lb. nearly and formulæ (a) gives

$$HP=\frac{V\ W}{550};$$

$$\text{but } V=\frac{\pi\ d\times r.p.m.}{12}=.2618\ d\times r.p.m.$$

which gives upon substitution

$$HP=\frac{w\ d\times r.p.m.}{2101} \qquad (1)$$

Again, if F=180. t=1-6, S=30. ; and we have by substitution as before:

$$HP=\frac{V\ w}{1100}=\frac{w\ d\times r.p.m.}{4202} \qquad (2)$$

A rule often assumed differs slightly from the preceding, and is,

$$HP=\frac{V\ w}{1000}=\frac{wd\times r.p.m.}{3820}; \qquad (3)$$

which corresponds to S=33lb.

Others use S=45 lb. giving

$$HP=\frac{V\ w}{733}=\frac{w\ d\times r.p.m.}{2800}. \qquad (4)$$

Prof. Kent seems to favor the assumption that the transmitting power of double belts is 10-7 that of single belts rather than that it is doubled. The first assumption applied to formulæ (4) gives

$$HP\ (\text{Double belts})=\frac{wd\times r.p.m.}{1960} \qquad (5)$$

which corresponds to S=64.3.

All formulæ given so far assume the arc of contact to be 180°, but should it be otherwise, the results given by the formulæ should be multiplied by $\frac{n}{100}$ where n is the number of degrees of contact.

If the velocity of the belt is more than 3,000 feet per minute the centrifugal force becomes so great that it tends to lift the belt off of the pulley, thus decreasing its tractive power though increasing the belt tension.

Mr. A. F. Nagle gives a formulæ to overcome this defect (transactions A. S. M. E., vol. II, 1881, p. 91, tables published in 1882).

$$HP=C\ V\ t\ w\left\{\frac{S-.0012V^2}{550}\right\};$$

$C=1-10^{.00758}fa$; (See table I.)

S=stress per square inch of belt section; otherwise the rotation is the same as before.

The results from Nagle's formulæ are given in tables II and III, and the various values of (c) in table I.

The horse-power of laced belts becomes a maximum 87.41 feet per second, and the riveted belt becomes a maximum at 105.4 per second.

TABLES I. VALUES of C.

DEGREES of CONTACT = A.

f	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	200°
.15	.210	.230	.250	.270	.288	.307	.325	.342	.359	.376	.408
.20	.270	.295	.319	.342	.364	.386	.408	.428	.448	.467	.503
.25	.325	.354	.381	.407	.432	.457	.480	.503	.524	.544	.582
.30	.376	.408	.438	.467	.494	.520	.544	.567	.590	.610	.649
.35	.423	.457	.489	.520	.548	.575	.600	.624	.646	.667	.705
.40	.467	.502	.536	.567	.597	.624	.649	.673	.695	.715	.753
.45	.507	.544	.579	.610	.640	.667	.692	.715	.737	.757	.792
.55	.517	.617	.652	.684	.713	.739	.763	.785	.805	.822	.853
.60	.610	.649	.684	.715	.744	.769	.792	.813	.832	.848	.877
.100	.792	.825	.853	.877	.897	'913	.927	.937	.947	.956	.969

Table III. Horsepower of Leather Belts one inch wide,

RIVETED BELTS, S=400

Thicknes in inches =t.

V	7/32 .219	1/4 .250	5/16 .312	7/32 .333	3/8 .375	7/16 .437	1/2 .500
15	1.69	1.94	2.42	2.58	2.91	3.39	3.87
20	2.24	2.57	3.21	3.42	3.85	4.49	5.13
25	2.79	3.19	3.98	4.25	4.78	5.57	6.37
30	3.31	3.79	4.74	5.05	5.67	6.62	7.58
35	3.82	4.37	5.46	5.83	6.56	7.65	8.75
40	4.33	4.95	6.19	6.60	7.42	8.66	9.90
45	4.85	5.49	6.86	7.32	8.43	9.70	10.98
50	5.26	6.01	7.57	8.02	9.02	10.52	12.03
55	5.68	6.50	8.12	8.66	9.74	11.36	13.00
60	6.09	6.96	8.70	9.28	10.43	12.17	13.91
65	6.45	7.37	9.22	9.83	11.06	12.90	14.75
70	6.78	7.75	9.69	10.33	11.62	13.56	15.50
75	7.09	8.11	10.13	10.84	12.16	14.18	16.21
80	7.36	8.41	10.51	11.21	12.61	14.71	16.81
85	7.58	8.66	10.82	11.55	13.00	15.16	17.32
90	7.74	8.85	11.06	11.80	13.27	15.48	17.69
1.00	7.96	9.10	11.37	12.13	13.65	15.92	18.20

Table II. Horsepower of Leather Belts one inch wide.

LACED BELTS, S=275.

Thickness in inches=t.

V	1/7 .143	1/6 .167	3/16 .187	7/32 .219	1/4 .250	5/16 .312	1/3 .333
10	.51	.59	.63	.73	.84	1.05	1.18
15	.75	.88	1.00	1.16	1.32	1.66	1.77
20	1.00	1.17	1.32	1.54	1.75	2.19	2.34
25	1.23	1.43	1.61	1.88	2.16	2.69	2.86
30	1.47	1.72	1.93	2.25	2.58	3.22	3.44
35	1.69	1.97	2.22	2.59	2.96	3.70	3.95
40	1.90	2.22	2.49	2.90	3.32	4·15	4.44
45	2.09	2.45	2.75	3.21	3.67	4.58	4.89
50	2.27	2.65	2.98	3.48	3.98	4.97	5.30
55	2.44	2.84	3.19	3.72	4.26	5.32	5.69
60	2.58	3.01	3.38	3.95	4.51	5.65	6.02
65	2.71	3.16	3.55	4.14	4.74	5.92	6.32
70	2.81	3.27	3.68	4.29	4.91	6.14	6.54
75	2.89	3.37	3.79	4.42	5.05	6.31	6.73
80	2.94	3.43	3.86	4.50	5.15	6.44	6.86
85	2.97	3.47	3.90	4.55	5.20	6.50	6.93
90	2.97	3.47	3.90	4.55	5.20	6.50	6.93

In tables II and III the angle (a) is 180°, but should it be multiply by

90°	100°	110°	120°	130°	140°	150°
.65	.70	.75	.79	.83	.87	.91
160°	170°	180°	200°			
.94	.97	1.00	1.05			

The problem usually presenting itself for solution is usually not to find the horse-power that a given belt will transmit, but to find a belt to transmit a given horse-power under some fixed conditions. This is easily found from any of the preceding formulæ by solving for (w), of course having due regard to the conditions under which the belt is to operate when selecting the particular formulæ to be used. A series of tables like those above, made to include some of the most common conditions of co-efficient of friction and stress per square inch of belt would be of great assistance in making the computations, as the width would then be:

$$W = \frac{H.\ P.}{p.}$$

H. P.=Horse-power to be transmitted.

p=Power per inch as taken from the proper table.

In erecting machinery the easiest way to find the length of belt for two given pulleys is to run a tape around them and deduct an inch for every ten feet of length to allow for stretch. This, however, is not possible for the designer, but he may find the approximate length by the following:

$L=(R+r)3\frac{1}{4}+2l$;
R=Radius of large pulley;
r=Radius of small pulley;
L=Length of belt;
l=Distance between centers;
a=Angle whose sine is $R-r \div l$.

The angle of contact with the smaller pulley is:

$$180^\circ - 2a;$$

and with the large pulley:

$$180^\circ + 2a.$$

The best speed at which to run a belt is about 4,000 or 4,500 feet per minute.

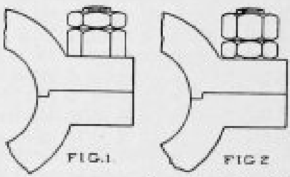
The working tension is not usually more than 500 pounds per square inch, or about 1-3 the ultimate strength of the joint, and averages about 275 pounds per square inch.

The Jamb Nut.

TO aid in the staying power of a nut on a bolt or stud the screw is made longer and a second nut put on and turned down tight upon the first.

Some designers are inclined to make this "jamb" nut thinner than the holding nut and to place it as in Fig. 1. It is found that in screwing down the top nut that the bolt is practically lifted out of the lower one and the top one carries the strain so that the nuts had better be arranged as in Fig. 2.

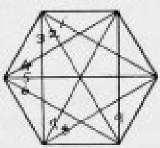
To make a neat appearance, the top nut should be chamfered, and since



jamb nuts are easily obtained in this style the top one should be made the same.

Diagonals of a Polygon.

The nnmbers of diagonals that may be drawn in a polygon bear some relation to the number of sides. From the illustration it will be seen that



nine can be drawn in a polygon of six sides and we can see that in one of four sides only two.

In an right sided polygon we have twenty seperate diagonals so it seems that the number does not stand any definite relation to the number of sides but from Geometry we find that the number of diagonals is

$$\frac{m(n-3)}{2}$$

where *n* is the number of sides.

Then in the case of six sides we have

$$\frac{6(6-3)}{2} = 9 \text{ as shown.}$$

Origin of the Oldsmobile.

IN 1887 Ransom E. Olds made the first practical gasoline automobile runabout known. This first wagon, which was a practical, though not altogether graceful machine, was made possible by the Olds gasoline motor, invented by Mr. Olds in 1885. The idea of applying this motor to mechanical traction began to grow in the inventor's mind, and two years later the first "Oldsmobile" made its appearance. It was a tri-cycle with wooden wheels and steel tires and weighed about 1,300 pounds. It was equipped with a single-cylinder motor, 3 inch bore by 6 inch stroke, hot tube ignition. The gear was a variable ratchet transmission. This was the first vehicle made to run by means of a gasoline motor in America.

With this machine as a basis for experiment, the work of improvement was pushed slowly but carefully, until in 1892 the second Olds wagon made its appearance on the road. This vehicle was a step forward, having four wheels of wood, with steel tires. The 42-inch driving wheels were placed in front and the 24-inch steering wheels behind. It was driven by a pair of cylinders 3 inch bore by 8 inch stroke, hot tube ignition. The transmission was a simple spur pinion and gear, three to one reduction, direct from the motor-shaft to the balance gear on the rear axle, with no reverse movement. This wagon was sold in 1892 to a London firm for $400. It was shipped to Bombay, and has never been heard from since.

In 1894 the third Olds motor wagon was started. It was the first to be equipped with tires. These were of solid round rubber, 1½ inches in diameter, on all four wheels. The wheel base of this new wagon was 54 inches, the rear wheels 36 inches in diameter, the front wheels 34 inches. The rear wheels were driven by three separate chains from sprockets on the motor-shaft to the rear axle, the rear axle sprockets having spring cushions interposed. The gear was three speeds ahead and a reverse by an intermediate spur pinion. The motor was a water-cooled, single-cylinder, 4½ inch bore by 8 inch stroke.

Arrangements were made to enter this wagon in the Chicago *Times-Herald* competition in 1895, but it was not ready in time, and consequently did not make its appearance. When perfected, however, this wagon proved so satisfactory that the possibilities for its success as a commercial venture were quite evident. Three wagons of this type were made, and one of them was sold for $900. One of them was used continuously by Mr. Olds up to the time of the organization of the Olds Motor Vehicle Company in 1897, with a capital stock of $50,000.

This company was superseded in 1899 by the present company. In the neighborhood of $80,000 was spent in producing expensive models of different types, most of which were really fine vehicles. Some, however, were too expensive, and all were open to one objection or another, which made them impractical for a wide market. Guided by all this costly experimenting, the company began anew, having by this time a definite object in view, *viz.*, the production of a runabout to weigh about 500 pounds and to sell as near to $500 as cost would permit. This called for the utmost simplicity of design and detail. In October, 1900, the new machine was produced and placed on the road for a trial. With the exception of the springs it was the Oldsmobile of the present day.—"*The Automobile.*"

Drawing Dimensions.

A lever arm was to be made of cast iron, and a drawing was made for the pattern shop illustrated by Fig. 1.

Shortly after the drawing was made it was decided to make a forging instead of a casting.

It was first thought that the same drawing prepared for the pattern shop could be given to the blacksmith.

While there is no doubt that an intelligent blacksmith could have made the lever arm from this drawing, but not without mental arithmetic.

As will be seen the dimensions as given are based on center lines which are preferred by patternmakers.

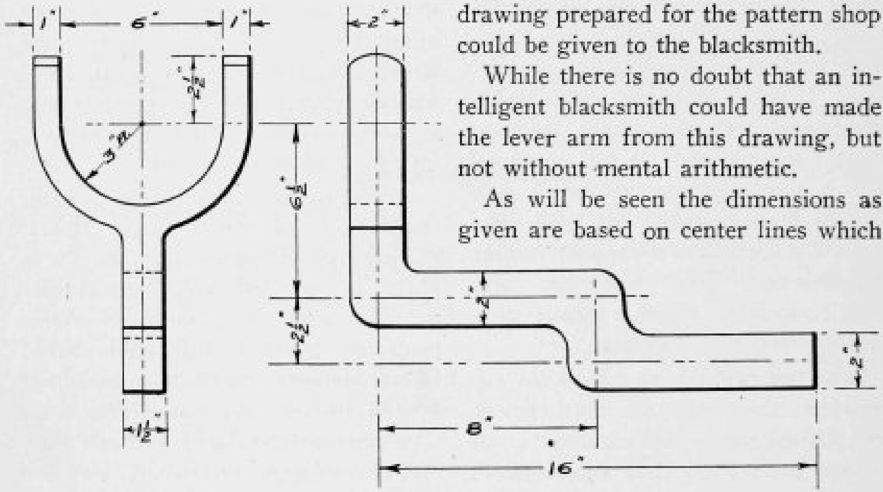


FIG. 1.

A blacksmith's work is most generally in the rough stage, and to work from center lines is impractical in many cases, this being one.

Therefore the dimensions were revised as illustrated by Fig. 2.

A. E. Eiserer.

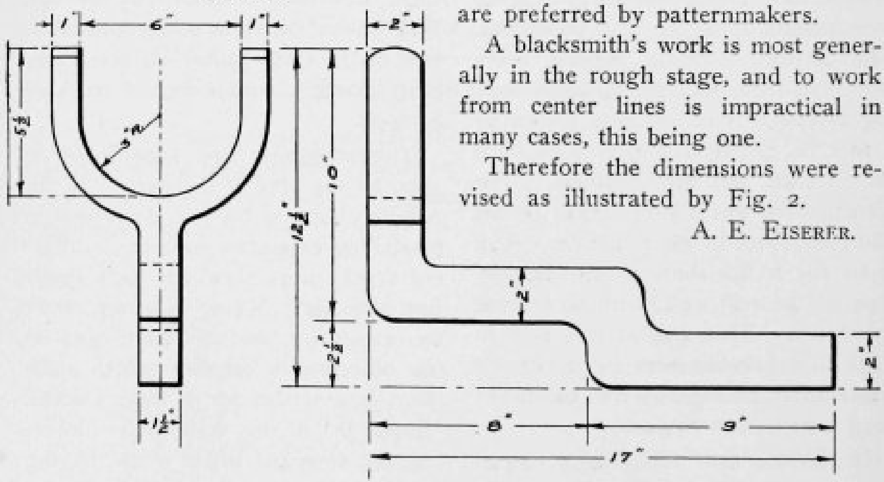


FIG. 2.

Change Gears.

The question of the change gears for lathes and the amount of time and inventive genius that has been devoted to the matter in the last few years would seem to render the subject one of considerable interest to the men who design lathes, the manufacturers, the buyers, and the men interested in the obtaining of patents upon the various devices.

Mr. Oscar E. Perrigo, of New Haven, Conn., has devoted much time and study to the subject, and the results of his investigation, which included the examination of 164 patents, has been put up in book form.

In "Change Gears" there are 29 of above list of patents considered and described, and their special features illustrated and compared in a way that will prove both instructive and useful to those interested in this line of mechanical work. It is printed on coated book paper, well bound, 5¼ x 7¾ in. pages. Price, $1.00. The Derry-Collard Co., Publishers, 257 Broadway, New York.

"Threads and Thread Cutting," being No. 4 of a series of practical papers published by The Derry-Collard Co., 256 Broadway, New York. Price, 25c.

It is a simple explanation of the mysteries of screw cutting by the various means used in the shop, and well worth considering when information is desired on the above subject.

Spiral Springs.

The effective number of coils is generally two less than apparent number, owing to flattening of ends. The stroke of a spiral spring is the effective number of coils × compression or extension of each coil. Diameter of coil should be about 8 times diameter of steel.

Where E=compression or extension of one coil in inches, D=diameter of coil in inches from center to center, d=diameter of round, or side of square steel in 1-16 of an inch W=weight applied in lbs., c=an experimental constant taken as 22 for round steel and 30 for square steel

---

Work is progressing rapidly on Brazil's pavilion at the World's Fair. It will be one of the largest and finest foreign government buildings. It will cost $130,000.

Alloy or Bearings.

A formulæ used on the Pennsylvania Railroad in making the standard bearings is as follows:

	Lbs.
Copper	105
Phosphor bronze, new or scrap.	60
Tin	9¾
Lead	25¼

CRUEL PUNISHMENT.

A man who was caught in the act of committing burglary at Paterson, N. J., was ducked several times in clean water and then told to leave town. It is reported that the friction he created in the air as he left almost set his clothes on fire.

There are abundant supplies of coal in Japan, not only in the northern island, but also in the southern parts of the empire.

ARCHITECTURAL.

Architectural Engineering.

BY SEWALD CHARLES.

IT may be said that structural engineering is the study of the skeleton of a building and treats only of the proper proportioning of the members, the stability of the structure, without regard to the ornamentation.

It is the purpose in this issue to merely state the definitions and terms in the simplest language possible, and these should be understood before going any further.

Mechanics is that branch of science which treats of the forces and effects upon bodies.

Force is that which tends to destroy or create motion.

Rest is that state in which a body lies when not acted upon by external forces.

Motion is the opposite of Rest.

Equilibrium is that state in which the forces are acting in the opposite directions and with the same intensity.

All draftsmen and designers should be familiar with Newton's Laws of Motion, as it is by these laws that all principles of mechanics are carried out. As the principles of mechanics are used for determining the reactions it is essential that they should be thoroughly understood before attempting any steel designing.

Now let us consider a beam about 20 feet long, supported at both ends, and having a uniform load of 500 lbs. per foot, and a concentrated load of 1,000 lbs. at the center.

We know from experience that the beam will bend to a certain extent, and in doing so the fibers in the upper half tend to push together or compress, this is *compressive stress;* those below the center line or neutral axis tend to stretch, this is *tensile stress.* At the points of the support there is another stress, *shearing stress,* caused by the beam tending to shear or slip down between the supports.

The dividing line between the tensile and compressive stresses is known as the *neutral line* and lies in the *neutral plane,* and this lies in the *center of gravity* of the beam. The center of gravity of a body is the point from which, if the body be suspended, it would be in equilibrium.

Now, again referring to the same beam, we notice there is a certain *deflection* which is in proportion to the load and the manner in which it is loaded. Should the load be removed the beam will tend to assume its natural shape, if the *elastic limit* has not been exceeded, and if it has and the beam does not return to its original shape upon the removal of the load, it is then said to have taken a *permanent set.* Consequently the elastic limit is the stress just great enough to produce the least permanent. It is usual in practice to try beams for deflection when they are to support very great loads, as this is of very great importance.

Suppose upon the removal of the load it is found that the beam in question had *stretched* or *elongated* and that it does not return to its original shape or length, then it is said to be strained beyond the elastic limit. This is called the *modulus of elasticity* and is the ratio of unit stress to the unit strain for loads within the elastic limit.

When a body is stretched or shortened it is said to have been subjected to a *strain* and the unit strain is the strain per unit of length.

$$S = \frac{E}{L}$$

S=unit strain.

L=length in inches of the body.

E=elongation in inches.

The *intensity of stress* is the stress per unit of area and may be found by the following:

S=unit stress per sq. in. in pounds.

P=Total stress in pounds.

A=Area of section in inches.

$$S = \frac{P}{A}$$

The *ultimate strength* of a piece of timber or member of a frame is that strength which is just sufficient to

SIX — Draftsman O'donnell 17

break it. In building it is not practical to allow a beam or column to carry its full load, because unforeseen loads may be imposed upon the structure which have not been allowed for, hence, a *factor of safety* is used, and is the ratio of the ultimate strength to the load it is required to carry. This number varies with the kind of material and the precautions to be taken. Usually the following are used: Steel, 3 to 4; Wood, 4 to 5; Cast Iron, 5 to 10; Stone, from 10 up, according to quality. A column required to support 100,000 pounds will not break until 300,000 pounds is imposed upon it if the factor of safety is 3.

The *modulus of rupture* is a constant used for determining the strength of beams, and varies as the strength of the material, as in steel 60,000 and 2,000 in stone of coarse texture.

The *moment of inertia* is another expression used to a very great extent in steel work, and depends upon the distribution of the body or on the surface with respect to a given axis. The formulæ for obtaining the same is as follows:

$$I^1 = I + ar^2$$

I=moment of Inertia sought.

I=moment of Inertia with respect to a given axis (found in tables of rolled sections).

a=area of figures.

r=distance from center of gravity to axis required.

The foregoing is often used in connection with another, the *radius of gyration*, and is equal to the square root of the moment of inertia divided by the area.

$$R = \frac{I}{A}$$

R=radius of gyration.

I=moment of inertia.

A=area of figure.

This is often made to read, ——— in which form it usually appears in the column and other formulæ.

Next issue Reactions and I Beams.

Organization of Twin City Architectural Club.

STEPS have been taken by the architectural draughtsmen of the Twin Cities to perfect an organization. Preliminary action was taken a few days ago and the organization will be perfected within the next two weeks. The association is to be known as the Twin City Architectural Club, and is to be for the study of architecture, and all matters pertaining to the allied arts and crafts.

The organization is to admit as active members only the architectural draughtsmen of the Twin Cities. The architects of the two cities have been invited to join as honorary members and the members of the different crafts employed on the finer parts of a building and known in architectural parlance as "material men" have been asked to come in as associate members.

The object of the organization is to promote and advance the science of draughting. It is claimed that the ordinary draughtsman working under an architect has little chance to show any originality and artistic talent that he may have. His work, it is maintained, is done according to the ideas and plans of another.

ANNUAL COMPETITION.

In order that each member may have to show and develop talent, the club will hold four competitions a year. The subjects and the rules to govern the contest will be arranged by a committee.

There will be three architects selected to act as governing board, who will pronounce on the merit of the sketches submitted. There have been draughtsmen's clubs in St. Paul and Minneapolis for sketching, but it was found that not enough members of the craft in one city alone could be secured to carry such an organization through successfully, so it was decided to have the two cities join.

The club will, from time to time, ask prominent architects to address the members on topics of interest to them. Engineers and other persons engaged in the construction of buildings will also be asked to address the club on subjects concerning the actual construction of a building.

SKETCHING TOURS.

The club will go on sketching tours throughout the two cities and State in the summer. Factories, mills and foundries will be visited and sketches made. Buildings in process of construction will be inspected and sketches made. These trips are designed to give the average architectural draughtsman a practical as well as theoretical knowledge of the construction of a building.

The next meeting of the club will be held in Minneapolis, February 19, when some one will be selected to lecture to the club on "Stained Glass," the lecture to be illustrated by lantern slides.

The following officers have been selected: President, Hal Eads; first vice president, George H. Blewitt, St. Paul; second vice president, Albert Van Dyke, Minneapolis; secretary, C. B. Chapman, Minneapolis; treasurer, John H. Wheeler, St. Paul; executive committee, F. G. Corser, Minneapolis, and Thomas A. Cresswell, St. Paul.

STRUCTURAL.

Structural Engineering.

As an I beam is very commonly used for structural purpose, it is quite essential we should be able to determine the proper size under certain given conditions.

The reactions being determined by the laws of the lever, it is necessary to understand their principles.

Figure I shows a simple lever which is in equilibrium and in which the greater distance from the fulcrum to point of application of load, and l the lesser distance from fulcrum to the point of application of the load.

A *moment* is the length through some given axis, as in the lever; the fulcrum, multiplied by the weight and expressed in inch-pounds foot-pounds or ton-pounds, depending upon the unit of length decided upon. In the case of I beams it is best to use inch-pounds.

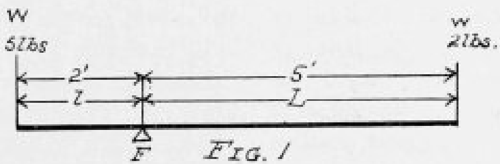


FIG. 1

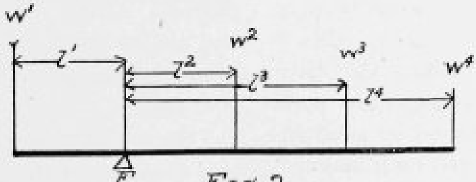


FIG. 2

case, as in all other cases, the force on one side multiplied by the length of the power arm is equal to the force on the other side multiplied by the length of the weight arm, hence the moments are equal and

$$Lw=Wl.$$

In this equation W equals the larger weight w, the smaller weight L

Suppose we consider a lever loaded Insert Fig. II.

The moments respect to the fulcrum F are

$$l_1w_1=l_2w_2+l_3w_3+l_4w_4,$$

and when so loaded both sides must balance.

Now as applied to a beam, which may be any one of the following: a fixed beam, or one in which both ends are securely held, a cantilever beam, or one in which one or both ends overhang the support, a continuous beam, or one which rests upon two or more supports, or a simple beam, or one supported at both ends, the last named being the one herein considered.

When a beam is supported at both ends there must be an upward pressure at the supports in order to balance the forces acting in a downward direction, and these upward forces are called *reactions.* In all cases the sum of the loads upon a beam must equal the reactions, and in any beam uniformly loaded the reaction at each support is equal to one-half of the load.

Throughout the entire beam there is a tendency of the fibers to shear or cut; this is greatest at the point of supports and decreases toward the center. Supose we call the shear at the right reaction or support positive and that at the left negative; then it follows there is some point between at which the shear is zero; this is called *the point at which the shear sign changes.* The shear at any point on a beam may be found by subtracting from the reactions, each succeeding load to the point considered. This is very necessary to know, as when a beam is not symmetrically loaded the point of change of shear sign must be found before the bending moment can be found, and the size of the beam determined. This will be more fully treated in a later issue.

In all beams there is more or less tendency to bend, and if the beam is uniformly loaded is greatest at the center of the beam, and if not so loaded the greatest bending moment is under the greatest load. The bending moment at the supports is zero, and increases as the tendency to shear decreases. In determining the size of I beams they are generally tested for bending stresses only. In the table given the different methods of loading are given.

Now let us consider the following problem: An I beam is to span an opening of 30 feet and carries a load of 500 pounds per running foot. Allow 3 for a safety factor and 60,000 pounds for modulus of rupture of steel. Determine the size of the beam.

As the beam is uniformly loaded, each reaction will equal one-half the load, or 7,500 foot-pounds, or the two will equal 15,000 foot-pounds.

By formulæ I

Bending moment=W (weight of load) ×L (length of span).

This equals 56,250 foot-pounds, or, multiplying by 12, 675,000 inch-pounds. Using a factor of safety 3 and the modulus of rupture of steel being 60,000 pounds, 60,000=20,000 pounds.

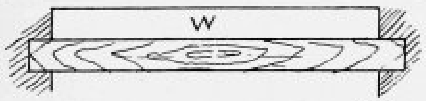
Then 675,000=33.75, or the section modulus of the beam required.

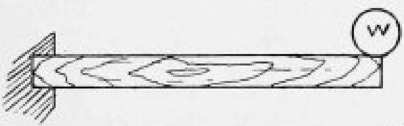
Now, looking down the table under the head of "Section Modulus," we find that a 12-inch beam weighing 30.6 pounds per foot has a modulus of section of 34.66, hence this is the nearest to the size and being on the safe side should be used.

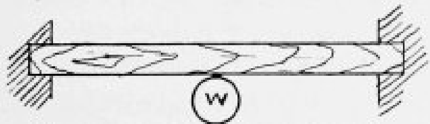
The deflection may be determined by applying the formulæ opposite the manner of loading, and using the

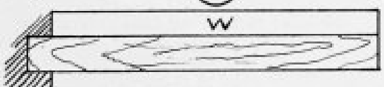
Standard I Beam.

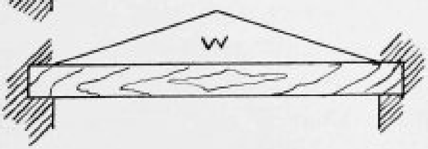
Depth of Beam.	Weight per Foot.	Area of Section in Inches.	Moment of Inertia on Axis x—y	Section Modulus on Axis x—y
4	6.3	1.80	5.01	2.52
4	7 4	2.16	5.83	2.90
5	0.3	2.76	11.57	4.65
5	12.4	3.60	13.35	5.35
6	11.9	3.50	21.13	7.05
6	32.2	9.49	52.52	17.50
6	46.1	13.56	68.56	22.85
7	14.6	4.31	35.42	10.12
7	17.9	5.29	39.43	11.26
8	17.3	5.13	54.30	13.57
8	21.2	6.24	60.27	15.07
9	20.5	6.04	80.78	17.95
9	20.4	7.47	90.50	20.11
10	23.5	6.91	112.42	22.47
10	30.3	8.91	129.08	25.83
10	34.9	10.29	153.94	30.80
12	30.6	9.01	207.91	34.66
12	39.4	11.60	268.31	44.72
12	55.6	13.62	362.89	60.47
12	66.9	19.67	403.39	67.24
15	41.2	12.12	433.01	57.73
15	52.9	15.57	497.67	66.37
15	56.9	16.75	560.78	74.78
15	69.2	20.39	709.89	94.68
15	85.1	25.02	789.25	105.23
20	64.9	19.04	1145.8	114.59
20	78.2	22.95	1367.36	136.75
20	98.3	28.95	1567.39	156.75











moment of inertia given in the table. Allow 29,000,000 for the value of E, the modulus of elasticity.

In determining the size of I beams the following course should be pursued: Determine the reactions if not uniformly loaded; if it is, find bending moment by proper formulæ and reduce to inch-pounds by multiplying by 12. Then divide the modulus of rupture of steel, usually taken at 60,000 pounds, by the factor of safety. Divide the bending moment by the last result, and this result will be the section modulus of the beam required. Looking in the table under "Modulus of Section" may be found a number equal to or near the one obtained. At the left of the table will be the size of the beam to use.

Bending Moment in Foot pounds.	Deflection
$\frac{W\ L}{8}$	$\frac{5\ W\ l^3}{384\ EI.}$
$W\ L$	$\frac{W\ l^3}{3\ EI.}$
$\frac{W\ L}{4}$	$\frac{W\ l^3}{48\ EI.}$
$\frac{W\ L}{2}$	$\frac{W\ l^3}{8\ E\ I}$
$\frac{W\ L}{6}$	$\frac{W\ l^3}{60\ EI.}$

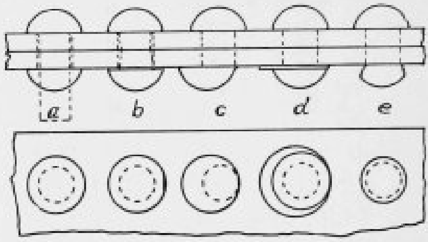
Note: l=length of span in inches.

Rivets in Steel Work.

C. J. TILDEN.

IN dealing with the question of rivets in structural steel work the writer does not pretend, in what follows, to make anything like an exhaustive investigation of the subject. The intention is merely to note briefly some of the differences between theoretical and actual conditions, which have been noticed in an experience of some years in shop and drafting-room, and to suggest, if possible, a means of comparison, in this particular instance, between theory and practice.

A theoretically perfect rivet should fill the hole completely, be of homogeneous material throughout and have two well-formed heads. The strength of a riveted joint depends, theoretically, on but two considerations: first, the shearing strength of the rivet material, usually soft steel; and, second, the number of rivets used. When comparatively thin plates are joined by rivets of large diameter, it may happen that the resistance of the metal to crushing is less than the shearing strength of one rivet; in which case the crushing or "bearing" value of the metal determines the value to be given to each rivet in calculating the strength of the joint. The question then arises, with what degree of safety may the designing engineer accept these theoretical assumptions, and how are they borne out by the conditions which occur in shop practice?



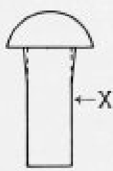
In the first place, the material of a rivet is not homogeneous. In a large majority of cases it is probable that test pieces taken from different parts of a rivet after driving, assuming that such small pieces could be properly tested, would show widely different characteristics, and these totally different from similar tests of the same rivet before driving. A very good idea of the great difference in quality of rivet material after driving may be gained by watching for a few hours a shop gang engaged in cutting out rivets which have been condemned by the inspector. Sometimes the metal is hard, tough and fibrous; then again nearly as soft, to all appearances, as lead or pewter; and occasionally the rivet head will fly off at the first blow of the hammer, apparently almost as hard and brittle as glass.

A second noteworthy discrepancy in the design of riveted joints is the failure to take account of the action of the rivet heads in bringing the two or more surfaces into very close contact, so that a large amount of friction is developed. It is quite possible that this friction may amount to more than the shearing strength of the rivet. In any event, it is a very important factor in the strength of a riveted joint.

In the diagram, Fig. 1, are shown some of the more frequent imperfections in rivet work, resulting from carelessness of the workmen. At *a*, for comparison, is sketched a perfectly driven rivet. The original form is shown dotted, the "shank" being 1-16 or 3-32 of an inch less in diameter than the hole which it is to fill, and enough longer than the "grip," or length between heads, to allow the formation of the new head, and the squeezing out of the rivet material sufficiently to fill the hole completely. Both heads should be concentric with the shank, and the rivet should be perfectly tight, giving a clear sharp ring when struck with a light hammer.

At *b* is shown a loose rivet which has been "caulked" with a cold-chisel, to make it appear tight under the inspector's hammer—a favorite trick of careless riveting gangs, and often very difficult to detect; if suspected, a close examination should be made of the head of the rivet for signs of the caulking tool, especially if the rivet has been generously bespattered with fresh paint or tobacco juice. Both these commodities, always plentiful in the shop, are favorite means of concealment for "scamped" work of this character. A result very similar to caulking, but much harder to discover, is sometimes secured by using the riveting machine, or "bull," as it is familiarly known to the shop men, on the cold rivet. The movable cup of the "bull" is brought sharply against the rivet head, securing somewhat the effect of a blow, and this is repeated four or five times on each loose rivet. In general, this machine caulking is not very effective, but the writer has known instances where it has been successful. It is well-nigh impossible to tell from the appearance of the rivet head afterward if this trick has been attempted. A very slight polish on the head of the rivet is about all the evidence that ever appears, and this is readily hidden by a dab of grease or dirt, or the ever-ready tobacco juice. It is a form of "scamping" that is seldom resorted to, however, as it is more work than caulking with the cold-chisel, and far less likely to accomplish its purpose.

The sketch *b* also shows the probable result of heating the rivet unevenly. When the heating is done in an ordinary portable forge, fired with coke, the forge-tender gets into the habit of heating



only that part of the rivet which is to be upset to form the head, leaving the remainder comparatively cool. Referring to Fig. 2, for example, from the lower end of the rivet to, perhaps, the point *x*, the metal is at white heat; above that it cools rapidly until the head is practically "cold," often not even a dull red color. This uneven heating not only prevents the rivet from upsetting throughout its length, and so filling the hole, but is apt to injure the quality of the metal above the point *x*, owing to its being worked under the hammer at too low a temperature.

Careless manipulation of the riveting-machine may result in the condition shown at *c*, where the head is not concentric with the shank. The fault can be detected only by comparison with the other rivets in the joint, showing uneven spacing and irregular lines.

The condition shown at *d* results from too much metal in the shank of the rivet before driving, giving a "soldier-cap" head. The reverse of this is shown at *e*.

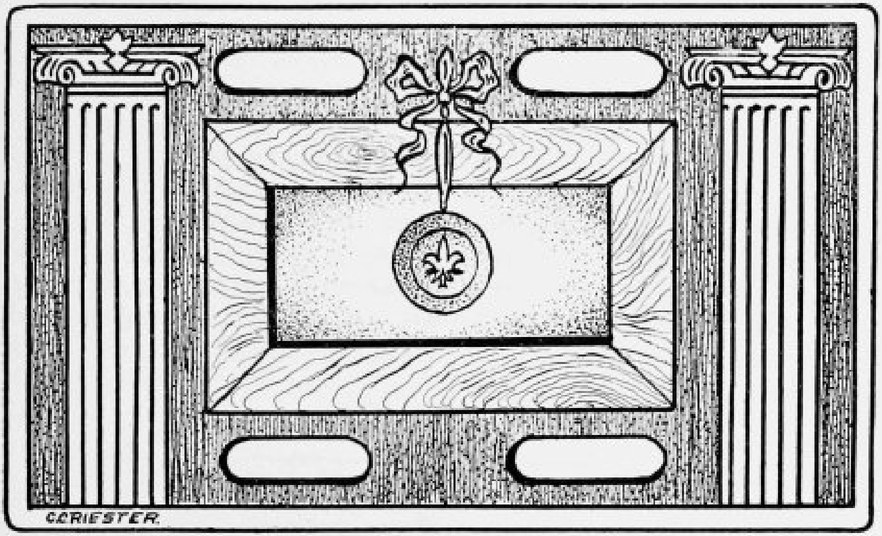
It must not be supposed that these defects are the only ones which occur in rivet work; they are only a few of the more frequent errors of this kind that may be observed in any shop. Combinations of two or more of the forms shown occur not infrequently, and an almost endless variety of changes may be rung on each one. Of the four types, *b* and *e* should be condemned unquestioningly whenever found, being not only bad workmanship, but unreliable. *c* and *d* probably develop the full strength of the rivet, and may be allowed to pass if strength is the only consideration; but if the work is to be exposed they should be cut out and replaced, as they are sure to look ragged in finished work.

As to the actual difference in strength between a perfect rivet, as *a*, and any of the imperfect ones, it is impossible to judge with any degree of accuracy. In fact, if a test were made it is quite conceivable that a rivet such as *b*, or even *e*, might develop greater strength than *a*. About all that can be said is that this is not likely to happen, but rather the reverse, as a properly driven rivet is more likely to develop its full strength than one which is imperfect in any way. But this is not reducing the question to any scientific basis, and, indeed, it cannot be so reduced. Rigid specifications are required for riveted work, and the work in the shop is subjected to the most careful inspection, not because a carelessly driven rivet is less strong, by any definitely calculable percentage, than one which is properly driven, for the simple reason that careful and accurate work is more reliable.

Figure 2 shows a form of rivet which has certain advantages and disadvantages over the ordinary shape. In this form the shank is slightly increased in diameter (exaggerated in the drawing) for a distance of ½ to ¾ of an inch from the head. Directly under the head, at the base of the cone-like enlargement, the shank has the same diameter as the hole into which the rivet is to go—that is, from 1-16 to 3-32 of an inch larger than the main part of the shank. This is an advantage in the shop, where the rivet is sure to be uniformly heated throughout its length, as it insures the complete filling of the hole up to the rivet head. In the field, however, where the rivets are likely to be unevenly heated, such a design would be of doubtful advantage. A rivet of this shape might easily appear sound and tight under the inspector's hammer, and yet have been very imperfectly driven.

Structural engineering especially has advanced so rapidly that its followers have had little or no time to devote to its purely experimental phases. It would seem as if a great deal of such work could be put into the technical schools, with much profit alike to the student and to the profession he seeks to enter.—*Extract from paper in Harvard Engineering Journal in Ryerson's Monthly.*

A Neat Panel Design.



Panama Canal Diggers Scale.

While the United States Senate is pondering over the diplomatic features of the interoceanic water way, the dredgemen and cranemen meeting in Chicago have decided what they would charge to throw aside the rocks and sands that separate the Atlantic from the Pacific. The scale adopted by the International Brotherhood of Steam Shovel and Dredge Engineers and Cranemen of America is to be paid in gold. Secondly, they demand free board. These two items disposed of, they raise the rate $50 a month for work in Panama.

The following is the scale adopted:

Panama Canal (per month), engineers, $300; cranemen, $250; Cuba and Mexico (per month), engineers, $160; cranemen, $125; United States and Canada (per month), engineers, $125; cranemen, $90.

HOME STUDY.

Elements of Descriptive Geometry

Descriptive geometry is that branch of science which deals with the methods of representing by drawings of all geometrical magnitudes or objects, and the solution of problems relating to these objects in space.

The idea in these drawings is to make them present to the eye, situated at a particular point, the same appearance as would the object itself, were it placed in the proper position.

These representations or drawings are the projections of the object and are generally made on plane surfaces (or simply planes) called the planes of projection, although they may be made on any surface, cylinder, sphere, dome, etc.

The point at which the eye is situated is called the Point of Sight. There are two general positions for the point of sight: one at an infinite (unmeasurable) distance and the other at a finite (measurable) distance. Let us see how these two general positions of the eye would affect the projections of an object on a vertical plane (V). We will take the straight line A for the object, and let (a) and (b) be points at the extremities of the line. (V) represents a plane perpendicular to the plane of this paper.

O, O′ and O″ are different positions of the eye, or Points of Sight. We see that for the finite positions O and O′ the projections of the object on (V) are larger than the object itself, and that the size of the projection varies inversely as the distance of the Point of Sight from the vertical plane. As this distance approaches infinitely the lines or rays of projection through points (a) and (b) be-

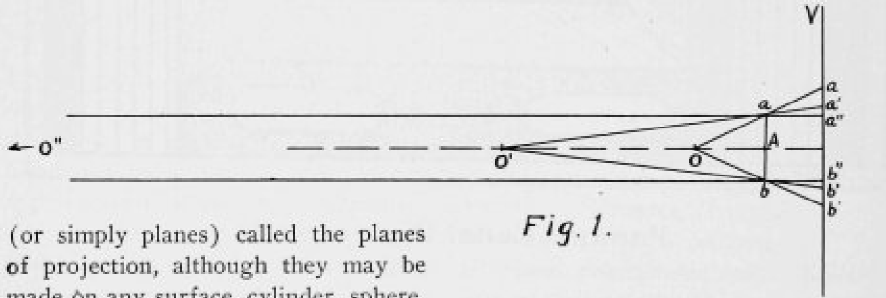
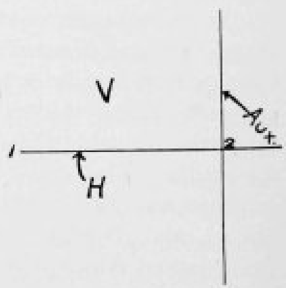


Fig. 1.



come nearer parallel to each other. In the case of O″ at infinity they are parallel and the rays of projection are all drawn perpendicular to the plane of projection,* making the projection of A on the vertical plane the same

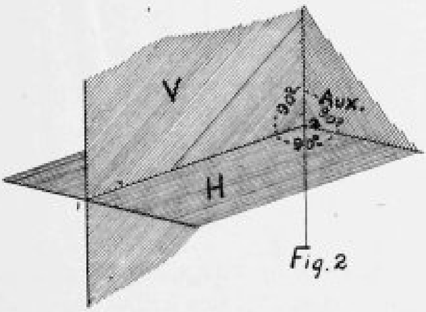


Fig. 2

size as A itself, A being parallel to the vertical plane. In case A were not parallel to the vertical plane given we would have to determine a new plane parallel to A or swing A about a point in itself until it should be parallel to the given vertical plane before we could determine its true length. The process will be explained later under Orthographic Projections.

tail.

Scenographic projections find their applications in decorating and architecture and in making sketches of the completed machine or other object, to accompany the working drawings.

For the present we will deal with Orthographic Projection only, and perhaps it would be well to state here the connection between Orthographic Projection and Mechanical Drawing. Mechanical Drawing is but a special case of the former in which it is customary to consider all objects as being in the *first* diedral angle (explained later), and supplementary planes are taken at right angles to the horizontal (H) and vertical (V) planes of projection. (Fig. 2).

Orthographic Projection.

Point of Sight is at infinity. Projecting lines or rays are all parallel to each other. The two planes of projection, horizontal (H) and vertical (V) are at right angles to each other and intersect in a straight line called

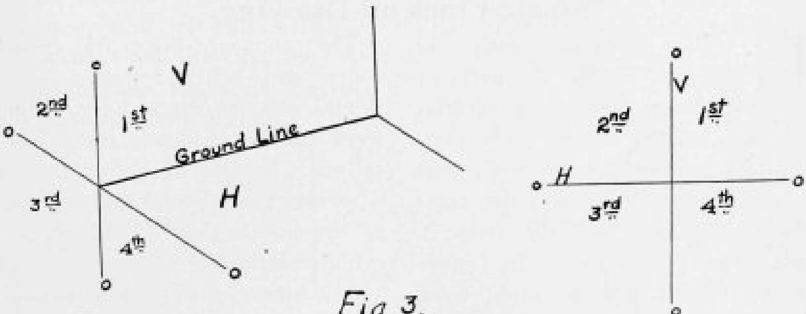


Fig. 3.

We have in the case of O″ orthograhic projection, and in the cases O and O′ scenographic projection.

Orthographic projections are used in making working drawings of objects and their parts with the idea of giving mathematical exactness of detail.

the *ground line.* These two planes divide space into four diedral angles, as shown by Fig. 3. Object taken in any one of the four diedral angles. Supplementary planes taken in any direction or at any angle with planes of projection.

In endeavoring to represent these diedral angles on a plane surface such as drawing paper, it is necessary to imagine one of the planes of projection together with the projected points in

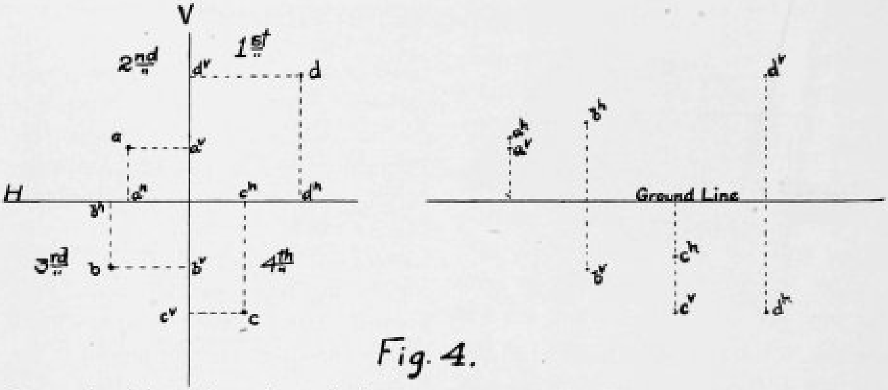


Fig. 4.

it revolved into the other. It is customary to consider the vertical plane (V) as revolved into the horizontal plane (H), the ground line or line of intersection of the two planes still being present to indicate the relative positions of the two planes before the revolution took place. Fig. 4 will serve to explain how this revolution affects the projections of points taken in the different diedral angles. a^v, b^v, etc., are the projections of points a, b, etc, on the V plane. a^h, b^h, etc., are the projections of the points a, b, etc., on the horizontal or H plane. Hereafter the horizontal plane will be denoted by H and the vertical plane by V.

Shade Lines on Drawing.

TO make drawings easier to read, and to make the parts of the object stand out more clearly, shade lines are often used. The general principle which determines what lines shall be shade lines is the same as that which governs shade lines in orthographic projection. If, however, this theoretical principle were to be followed out exactly on drawings of machines and other complicated objects, it would involve a great deal of time and labor. Consequently, most draftsmen place shade lines on all lines which represent lower and right-hand edges.

The contour lines of cylinders, cones and other rounded surfaces should not be shade lines, although some draftsmen shade them. If the cylinder is drawn in cross-section, however, the edge should be shaded, as the intersection of the plane and cylindrical surface is a sharp edge.

All views are shaded alike, and both are shaded as though they were elevations. The ray of light is supposed to come over the left shoulder of the draftsman as he faces the paper, at such an angle that the projection of the ray of light on the drawing paper is in the direction of the arrow

Figs. 1 to 8 show some of the most common shapes met with in drawings, and illustrate how the shade lines are placed on each. Fig. 1 is an eleva-

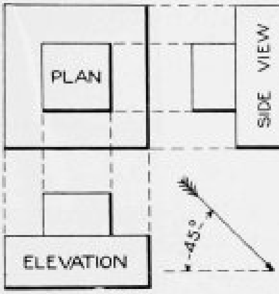


Fig. 1.

tion, plan, and side view of a rectangular prism with a smaller one resting on top of it. Fig. 2 is a plan and side view of a rectangular prism with a rectangular hole through it. It is to

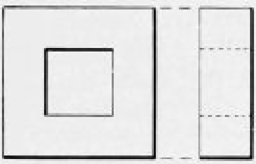


Fig. 2.

be noticed that the shade lines come on the upper and left-hand sides of the hole, since these lines are the lower and right-hand edges of the material which surrounds the hole.

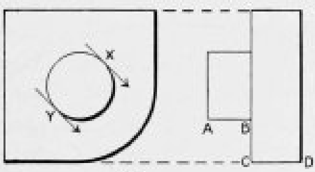


Fig. 3.

Fig. 3 is a plan and side view of a rectangular prism with one corner rounded, and with a cylinder resting on it. Here the lines A B and C D are not shaded, since they are the contour lines of curved surfaces. In the plan view, the lower right-hand part of the circle, between X and Y, is shaded. To find these points X and Y, draw two lines tangent to the circle and making an angle of 45° with the T-square line; X and Y are the points where the arrows are tangent to the circle.

Fig. 4 is a plan, elevation, and cross-section of a cylinder. Here, in the plan, the larger circle is shaded on the lower side, and the circle which

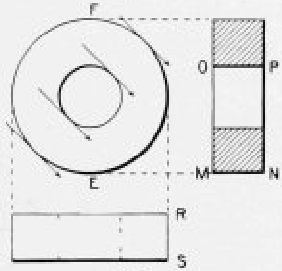


Fig. 4.

shade begins are determined as explained for Fig. 3. The lines M N and O P are shaded, since, as the cylinder is supposed to be cut open, these lines now represent sharp edges.
represents the hole is shaded on the upper side. The points where the

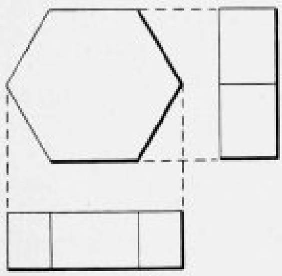


Fig. 5.

Fig. 5 is a plan, elevation and side view of a hexagonal prism, with its long diameter parallel to the bottom of the paper. Fig. 6 is the same, except that here the short diameter of the prism is parallel to the bottom of the paper.

Fig. 7 is a plan and end view of a rectangular block, with a wide slot

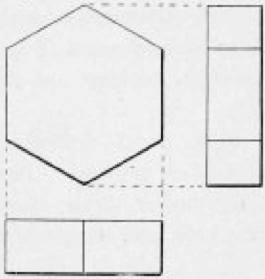


Fig. 6.

of the shape H I J K M L O N cut through it lengthwise. The main point to which attention should be called is that the line C D is shaded,

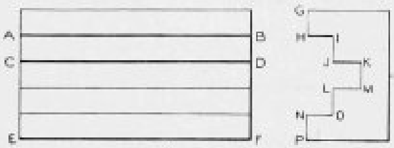


Fig. 7.

although the slot might be so deep that the light might not strike in there because of the shadow of the projecting lip marked in the side view G H I.

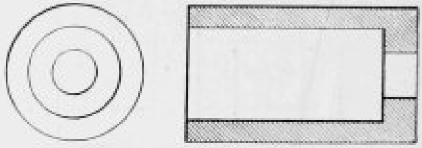


Fig. 8.

Fig. 8 is a cross-section and end view of a circular cylinder with a large hole extending part way through and a smaller hole extending the rest of the way. The small circle in the end view is shaded, although it is so far in that no light could strike it.

These simple figures show how the shade lines are determined, so that when similar forms occur in machine drawings the shade lines are easily placed.—*The Technical World.*

The Isometric Circle.

BY A. EDWARD RHODES.

FOR a number of years I have been using a graphic method for drawing isometric circles, both in the drafting room and in my school classes This method, Fig. 1, deserves to be better known. It possesses the merit of having fewer construction lines, and also of the ease with which the length of the major axis of the isometric circle may be made to equal the diameter of a given inscribed circle.

Illustration: Let it be desired to make an isometric drawing of an inscribed circle X diameter.

1st. With a radius X draw two circles touching as at A.

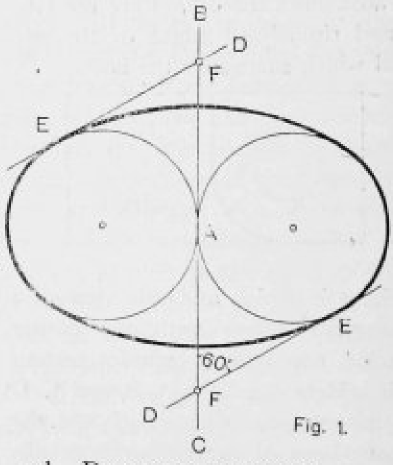


Fig. 1.

2d. Draw a tangent B C, common

to the two circles.

3d. Draw lines D at 60 degrees to the line B C and touching (tangent to) the circles as at E. This gives the centers E on the line B C.

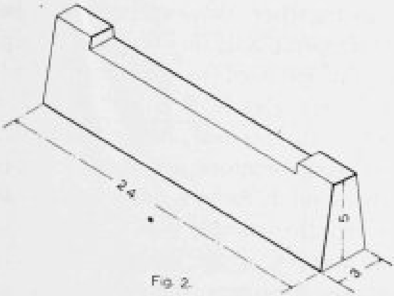


Fig. 2.

4th. Use F for centers and draw arcs cutting the circles at E, thus completing the curve. Suppose the inscribed circle to be 2″ diameter; then X—2=.5 of an inch, and the major axis of the drawing will be .5×4—2″.

From the above it will be seen that it is possible to make an isometric drawing of any inscribed circle by using a scale of standard inches, and without having recourse to a specially constructed isometric scale.

In regard to elevating the drafting board, I do not like the castings advocated by Mr. Babbitt in the January DRAFTSMAN, but would prefer, in fact use them in my night school, the wooden blocks shown in Fig. 2. This block costs less to make, anyone can make it, and it will not punch holes in the drawing board.

Editor The Draftsman.

Dear Sir: If you will allow me a little space in your valuable publication I will endeavor, for the benefit of the student of the "Home Study Department" to elucidate the problem published in the December issue, on pages 301-2. The writer there says, referring to the diagram on page 301, that K E equals C E, and asks at the close of his demonstration, "Where is the error in the proof?" The error is found in the assumption that K E equals C E. Now, if all those who do not know, and are interested in knowing, to the extent of constructing a diagram, according to the instructions which follow, the result tending to show whether the above assumption is true or false, will be so plain that he who runs may read. So get to work and spike down a piece of paper, about the size of the page which contains the diagram, and point up your pencils good and sharp; no ink will be needed. First, construct the square shown in the diagram, A B D C, and bisect the side D B, in G, and at that point erect an indefinite perpendicular, and on it from point G set off G E, equal to the same distance in the original, join E B and E D, also E C and E A. With B as center and A B as radius, describe a circle, the circumference will pass through the points A and D if you have drawn a square. On this circumference from A set off a distance equal to the arc A K in the original, and from that point draw K E and K B; now letter your diagram the same as that in the Draftsman, and then you can lay the publication aside. With E as center describe another circle, this latter circle will be tangent to the circle described about B at some point in its circumference, and to locate this point with precision you have only to prolong B E to cut the circumference.

The point of intersection will be the point required; denote this point by P, and we will denote the smaller circle by D, because it passes through that point, and the larger circle by S, which you may place near the circumference at any convenient point; denote the point where circle D cuts the line P E near E by letter N, and the corresponding points in the lines K E and A E by the letter O and M respectively. The two circles S and D are tangent to each other in the point P, that is to say, they touch each other in that point, *and in that one point only*, and every point in the circumference of circle D except P is within the greater circle S. Now P N is a diameter of circle D, for it passes through the center B; a diameter is also a chord, and it is the longest chord that can be drawn in the circle; also, K O and A M are chords, in the same circle, and of all the chords that can be drawn in any circle, that which is the greater subtends the greater arc, in your diagram. This statement is proved to be true by mere inspection, it is self-evident, for surely the arc P D N, being a semi-circle, is greater than are A D M, which is not a semi-circle, therefore the chord K O is greater than A M. The whole line P E is a secant of circle D; also K E, A E, and D E are secants to the same circle. Now, what has been said of chords applies to secants when drawn from a common point without the circle, as in the diagram, the greater secant will intercept the greater arc, the arc K D O is greater than arc A D M, therefore K E is greater than A E, hence they can not be equal, but A E is equal to C E by construction, therefore C E is not equal to K E. Points K and A are both on the circumference of circle D. When two triangles are equal and similar, if they be placed one upon the other so that corresponding sides will fall together, they will coincide in all their parts, and this is a test of equality often used in geometry, but the two triangles K B E and A B E will admit of this test, hence they are not similar, therefore not equal. Suppose the point E to be a fixed center, about which the triangle K B E may be made to revolve, while triangle A B E remains stationary, the side B E is common to both triangles, and in this case the side of one triangle coincides with the side of the other; but suppose the point K to move towards the point A when the side K E coincides with the side A E, the side of the triangle K B E, which corresponds to B E, will form an angle with the corresponding side of triangle A B E similar to angle A E K, and by no arrangement can all the sides of the triangles be brought into coincidence, therefore, the two triangles are not equal, but triangle A B E is equal to triangle C D E by construction, therefore, triangle C D E is not equal to triangle K B E. Much more that is interesting and instructive could be said about your diagram, but this article is already too long.

FLORENCE W.

DURABLE WOOD.

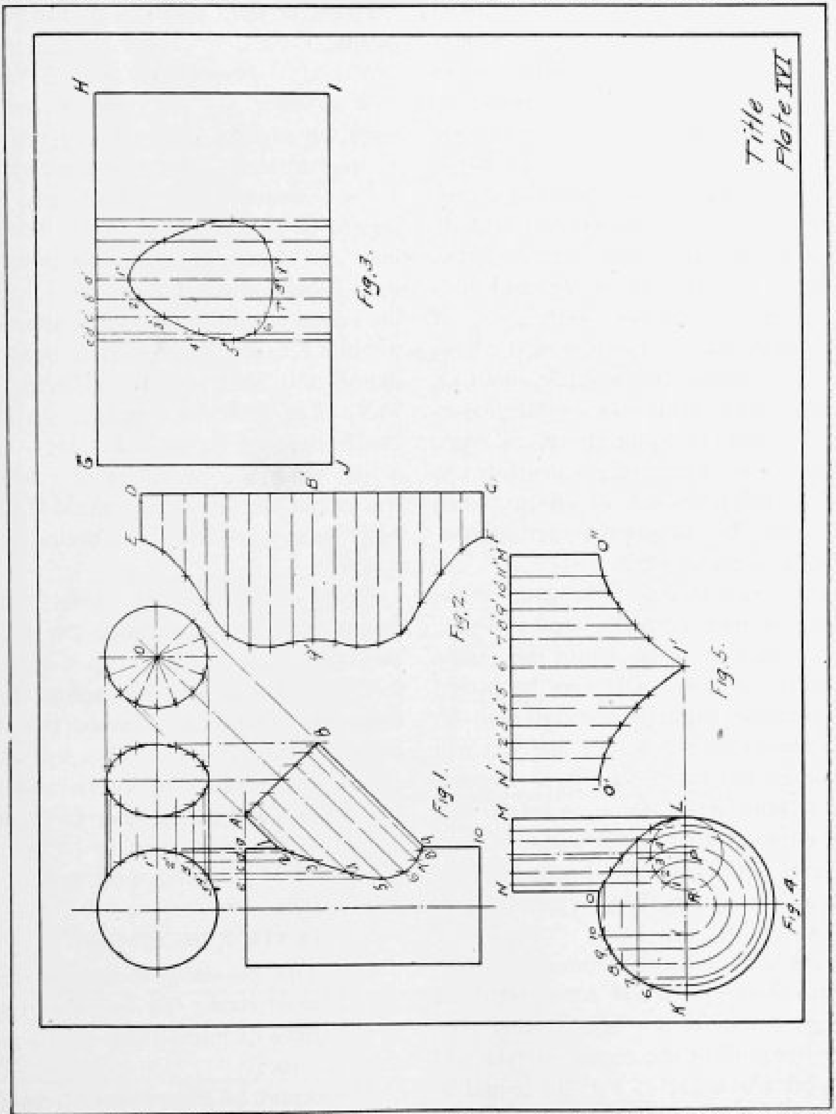
One of the most durable woods is sycamore. A statue made from it, now in the museum of Gizeh, at Cairo, is known to be nearly 6,000 years old. Notwithstanding this great age, it is asserted that the wood itself is entirely sound and natural in appearance.

Elementary Mechanical Drawing.

Continued from March.

PLATE XVI — Promblem I.

To lay out the development of two cylinders which intersect each other at an angle of 45 degrees.



The vertical cylinder is 2″ in diameter and the inclined one is 1¾″ in diameter. The center line of the top views is 2″ from each border line and the base of the front view is 7½″ from the top border line. The inclined cylinder intersects the vertical one at a point ½″ below its upper face. Its length is determined by drawing AB, through A the intersection of 1, and the upper base of the vertical cylinder. O is the intersection of the center line of the inclined cylinder with the center line of the top views. With O as a center, draw a circle whose diameter is AB and lay it off into equal arcs as shown. Now project the points so found upon AB and draw the elements of the inclined cylinder. The ellipse which represents the horizontal projection of the end at AB is found by drawing vertical lines through the points already found on AB, and finding their intersections with a set of horizontal lines drawn through corresponding points on the circle about O.

This is called the horizontal projection because in using the third angle of projection the object is projected to the horizontal plane. It is projected *vertically*, but is *not* the vertical projection of the object.

The line CD, Fig. 2, is equal to the circumference of the inclined cylinder, and should be divided into the same number of parts. CD may be placed 8″ from the right border line and D, 1¾″ from the top border line. It will be seen that there are two element lines from CD of the same length and the curve will be symmetrical on each side of 9′, FC and ED being equal to AI and so on to B′ 9′, which will be equal to B9.

GH is the circumference of the vertical cylinder and GJ is equal to its length a 10. H is 1″ from either border line. Find the center of GH and lay off a′b′ equal to 1′2′, b′c′ equal to 2′3′, and c′ d′ equal to 3′4′ and d′e′ equal to 4′5′.

The same spacing should be made no the right of a′.

The lengths a′1″ will be equal to a1, a′9″ will be equal to a9, b′2″ will be equal to b2 and b′8″ equal to b8 and so on.

Draw in the curve through the points.

Promblem II.

A cylinder 1¼″ in diameter intersects the surface of a sphere which is 3″ in diameter. The center which is 3″ in diameter. The center of the sphere is 2″ from each of the border lines and the center line of the cylinder is ⅞″ from that of the sphere. Let the center line of the cylinder intersect the line KL and draw a circle equal in diameter to that of the cylinder, or MN. Let M′N′ be equal to the circumference of the cylinder MN. N′ is ½″ from M. A series of concentric circles are drawn in around R cutting the circles about P in points 1, 2, 3, 4, etc.

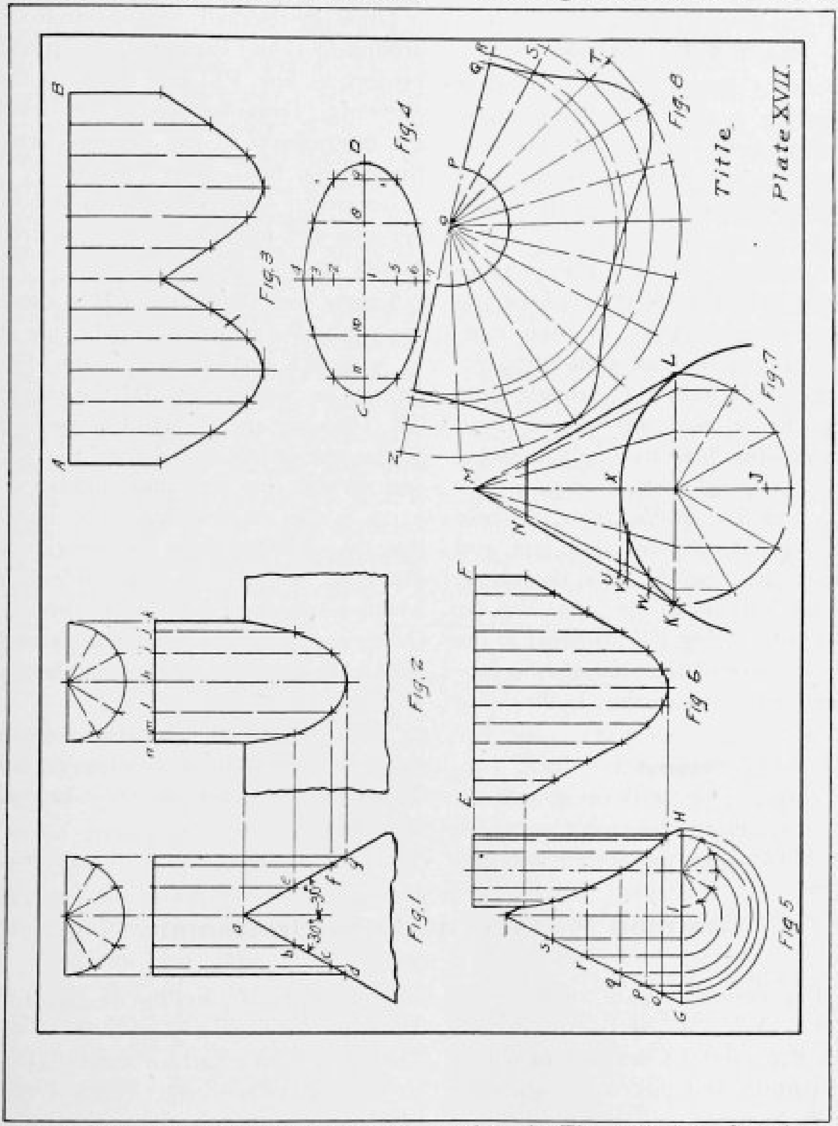
Draw vertical element lines from points 1, 2, 3, etc., through the cylinder, also draw the lines up to points 6, 7, 8, 9, and 10 and then across from these latter points to intersect the elements of the cylinder. This will give points in the curve of intersection of the cylinder and the sphere. N′ O′ and M′ O″ will each be equal to NO. Also N′ 1′ and M′ 11′ are equal to RI approximately.

PLATE XVII—Problem. 1

A 2″ pipe passes in through the top of a peaked roof. To find the shape of the curve of intersection of the pipe with the roof.

The center of Fig. 1 is 2″ from the left border line and the center of Fig. 2 is 4″ from that of Fig. 1. The peak of the roof is 3½" below the top border and the top of the pipe 1½" above the peak of the roof.

To find the development of the pipe,



find the circumference of the pipe and lay it out on line AB and then proceed as in the previous problem. AB is ½" below the top border line. Fig. 4 is a development of the hole through the roof. CD is 5" below the top border line and 4—7 is on the center of AB.

The lengths 1—C and 1—D are ac and ag in Fig. 1 and 1—8 and 1—10 are equal to ab and ac, 1—9 and 1—11 are equal to ac and af respectively. Then 1—2 and 1—5 are equal to hi and hi and 1—3 and 1—6 equal to hj and hm and 1—4 and 1—7 equal to hk and hn respectively. Project these points and draw in the curve with the aid of the French curve.

PLATE XVII — Problem 1

A cone 3″ in diameter by 3″ high is pierced by a pipe 1¼″ diameter set ¾″ off the center of the cone. The base of the cone is 2″ from the bottom border line and the cone is on the center line of Fig. 1.

Extend the center line of the pipe to line GH and draw the circle of the cylinder and divide it into an even number of parts and draw concentric circles about the center I through these parts. From the intersection with line GH draw lines to o, p, q, r and s. Draw horizontal lines from o, p, q, r and s and find intersections of these with the elements of the pipe and through these points draw the curve. The development of the pipe (Fig. 6) is found by laying EF off equal to the circumference of the pipe and by projecting across from points in the curve of Fig. 5.

Problem 3.

A conical pipe rests on a cylinder 5½″ in diameter, the center of which is at J, ½″ from the border line and 7¾″ from the right border line. The apex of the cone is 3½″ above KL and the cone is 4″ at the base and 1″ at the top in diameter, KL being 4″.

Draw in the half circle from K around to L and divide as shown and project to line KL and draw in the elements. Draw horizontal lines from the intersection of the elements with the cylinder KXL to u, v and w.

Locate O, 3½″ from the right border line and 6½″ from the bottom border line.

From O with a radius of MN, draw the arc at P and with MU the one at Q, with MV the one at R, with MW the one at S and with MK the one at T. Then the arc T should be as long as the circumference of the base KL and divided into the same number of parts, in this case, twelve. The arc T may be extended into the margin of the sheet, so to cross the line RO which is determined by laying the line OZ up near Fig. 4 and stepping around on arc T until the proper number is secured.

The elements are then drawn in to the point O from these divisions on arc T and the points for the curve located as shown.

Common Mistake made by Draftsman.

BY J. HAYS.

IT sometimes occurs when you may have a hurry repair job which necessitates a drawing of which both pattern and piece in question have to be made.

In making the drawing, the draftsman has been very particular to make a neat finished drawing and has left out the principal part, the dimensions. Take for instance a piece of work coming in from a pattern which has to be made and then the castings finished, and as the piece cannot be left in the shop only long enough for a draftsman to do the drawing, the drawing is made and the pattern-maker is requested to leave enough on for finish, as this drawing is also to be used in the machine shop.

The drawing is finished and given to the pattern-maker; first thing is, how long or how thick is this to be? No size or anything is given. Is this drawing made to a scale? Of course it is; then I suppose if I scale the drawing it will be all right. The pattern-maker makes his pattern according to the drawing scale, then it is up to the machinist. He is supposed to make it exactly the size. Where will he get his size from? Guess at it, and nine times out of ten he will get it too small. He cannot measure the old piece, for that has been put back in the machine. The piece is finished as nearly as possible according to the directions given by the draftsman, and sent to the party ordering it. He is the one to find the mistakes and returns it to be made good. It is not his fault that it is made too small, and the consequence is, it will have to be made over again, and maybe the pattern also, gratis. Where does the boss come in? All his profit and more, too, gone, and whose fault was it? All on account of not putting in the proper dimensions.

A draftsman cannot be too particplar in being sure he has put in all the proper dimensions, and also enough different views to enable the workman to tell exactly what is wanted. Never mind putting on an extra lot of time lettering and finishing, for if the drawing has no dimensions given, it is nothing more than a picture, and no workman can work from a picture, a sketch on the back of an envelope with all the dimensions on it is better than all the drawings or blue prints you could mine the proper size under certain make without dimensions as far as working after it is concerned.

Hydraulics and Law.

The ridiculous position in which an engineer may find himself by following the "friction formulæ" is here reproduced from the expert testimony of a local hydraulic engineer, who was trying to explain the flow of water through long pipes.

Question. Mr. Expert, in estimating the flow of water in long pipes, how do you determine the friction, or resistance, to the motion of the water, caused by the interior walls of the pipe?

Answer. By the diameter, length, internal condition and curves of the pipe, together with the hydraulic head.

Ques. Then the longer the pipe, the smaller the discharge, and the slower the motion?

Ans. Yes, sir.

Ques. Should the pipe be long enough the friction would overcome the head and the flow would cease?

Ans. Yes, sir.

Ques. Then, if the water came to a rest, the resistance caused by the friction would also cease, would it not?

Ans. Yes, sir.

Ques. Would not the water start up again at full velocity?

Ryerson's Monthly.

Current Topics.

Our Supplement.

While the supplements we issue each month are some additional trouble to us in preparing and inserting, it is believed that they are of such nature as to warrant a welcome by most every draftsman.

Some of the supplements to the future issues will be on standard machine and set screws, railing bases, rail and I beam washers.

The Draftsman has received several letters with money for subscriptions with no address in the letter.

Always be careful of this part when you write a letter; it will save time and money often, besides the inconveniences arising from the delays caused. Remember the address; if it is there and not the name, we can reach you.

About Draftsmen.

Whatever may be said against trusts, one thing noticeable is they always increase the number, the pay, and raise the standard of draftsmen at the plants retained in operation. If draftsmen are an "expensive luxury," they are the first men around the shop to go when business "lets up," for they are easy to get, thanks to the correspondence schools. Why should combinations have their chiefs hunt four to six weeks for one man to take the place of someone who has dropped out because a man does not count in a trust plant? Yes, the trust gets the credit with doing smaller things to increase profits than any independent company would think of doing.

It isn't what you do that will hold you a position in so many plants, but the way you do it. Don't wonder why the last man into the room is retained after yourself and others are let go that the salary list in the engineering department be made in keeping with the amount of business done. Doubtless your assertion that results count may be true, but how did you create those results—like the old woman that kept the hotel in Indiana?

The Difference.

The difference between salary and wages is precisely the difference between accepting a position and getting a job.—Detroit Free Press.

Head draftsman L. D. Rosenbauer, of The Wolf Co., is home from a business trip to Richmond, Va.—*Chambersburg (Pa.) Repository.*

Oscar F. Mead, of Detroit, has been appointed a draftsman in the United States patent office at $1,000 per annum.

There is a great demand at the present time for brick making machinery in Cape Colony, Natal, Orange river colony and the Transvaal.

The Oldness of Things.

When one stops to think of the numerous technical articles that are published now and the difficulty in obtaining entirely new matter so that the old readers may not say "Oh, that is old; I knew that twenty years ago," we wonder what will be next.

There are always experimenters like Hewitt, Currie and others that are bringing out some new things to talk about that all our matter is not old, yet that which is repeated is clothed in a new style and appears new to many.

A good thing should never grow old and in repeating it in a new dress often an idea comes to the reader that never appeared that way before.

What if some article does have an old appearance, one must remember that there are more readers that have never seen it than have.

In arranging matter for publications a writer often takes up a subject old to him and sometimes to others, yet he could not well write on something with which he is not familiar. Suppose he rehash some article, add his views and a few sketches to it, he has made it clearer for someone perhaps who is less favored with a quick perception.

Then, too, a writer should not leave the reader to guess too much, even if the matter under discussion is as old as the hills.

In looking into many text books, we find formulæ plain and simple, yet which mystifies many readers because some little explanation is lacking.

For instance, in some books on design where the formulæ have been derived from experience and arranged to fit most practical cases, parts of them are based on the size of some body generally known, say the diameter, but to it is added ¼, 1-16 or 05, as the case may be.

Now the writer thinks that the reader will understand that you simply add these for looks, not strength, and it is such an old thing that it needs no explanation.

It might be said here that these formulæ are often more confusing than useful, and a word about this might not be amiss.

Suppose we had an expression $t = .02d + .5$ for the thickness of an engine cylinder in which d is the diameter. Then if d was to be 10", we multiply .02 by 10, which gives 0.2 and adding .5 makes .7 and call it inches. If d was in centimeters, then the answer would be .7 centimeters.

Not long ago we saw a copy of a trigonometry that had in the text many letters of the Greek alphabet, but on the fly leaf of the book was found the names of the letters.

Old, yes, old, about 2,500 years old, but absolutely necessary that it was repeated again for the benefit of the reader.

Some of our text books have an old way of showing proportions of parts in designs of different machines.

The object is proportioned to a certain *unit;* we see a note that the unit is D or the unit is $D \times 1.15$, meaning that all the figures in the illustration are to be multiplied by the value for D or the result of $D + 1.15$, and if D be in inches, the final result is in inches.

So we find many old things not explained. The writers are bubbling over with the subject in hand that they forget that all minds are not alike and able to see as readily as he, who has generally set up nights to absorb a large supply of that particular theme.

The old things are new to many, to a great many, we might say, and should never be cast aside when clearness is desired.

The Thermometer Scale.

How It Happened to be Divided in an Apparently Senseless Way.

WHY should the freezing point be marked 32 degrees and the boiling point 212 degrees on the Fahrenheit thermometer scale? Most students know that its inventor divided the space between these points into 180 degrees instead of the simpler 100 degrees used in the centigrade system, but few understand how this number came to be chosen. A writer thus explains the matter:

The thermometer was really invented by Sir Isaac Newton. He started his scale with the heat of the human body and used as his instrument a glass tube filled with linseed oil. The lowest figure on the scale was the freezing point and the highest point boiling water. The starting point of this scale, as mentioned, was the heat of the human body, which he called by the round number 12, as the duodecimal system was then in common use. He divided the space between the freezing point and the temperature of the body into 12 points, and stated that the boiling point of water would be about 30, as the temperature must be nearly three times that of the human body.

When Fahrenheit took up the subject a few years later he used the Newton instrument, but, finding the scale not fine enough, divided each degree into two parts, and so made the measure between the freezing and boiling points 24 instead of 12. Fahrenheit then discovered he could obtain a lower degree of cold than freezing, and, taking a mixture of ice and salt for a starting point, he counted 24 points up to body heat. By this measurement he obtained 8 for the freezing point and 53 for the boiling point. His scale now read: Zero; freezing, 8; body heat, 24, and boiling water, 53. It will be noticed that this scale is identically that of Newton's; only starting lower and having the numbers doubled.

It was with this scale which Fahrenheit worked for a long time, but finally finding the temperature divisions still too large, he divided each degree into four parts. Multiplying the numbers just given by four, the thermometer scale now in use results.

The chance choice of Newton of the figure 12 to represent the body heat determined the present thermometer scale, even as the yard, feet and inches measures originally came from measures of parts of the human body, and as the width of the railroad carriage was determined by the track, which, in turn, was determined by the width between the cart wheels necessary to bear a load which could be comfortably be drawn by a mule.—*American Inventor.*

Spurns Flag as Sign of Liberty.

With the Stars and Stripes reflecting their colors in his eyes, no matter toward which wall he turned, William D. O'Brien, toastmaster at the banquet of Contractors and Builders at the Auditorium hotel refused to toast the flag as an emblem of liberty.

"Why the emblem of liberty is a farce," he cried, "when men are shot down in the street because they are trying to earn an honest living; when we are afraid to assert our rights for fear some labor organization will oppose us."

The banquet hall was thronged with delegates to the national contractors' conference and members of the contractors' council of Chicago, by whom the feast was spread, and, as Toastmaster O'Brien uttered his opinion of what he characterized a fettered liberty, the big hall was made to echo with cheers of approbation.

"It is ridiculous," he declared, "to think you should be obliged to waste your time discussing your rights with walking delegates, business agents and labor leaders. You have your rights, and no man should be able to step in and dictate to you and tell you where your rights begin and end.

"We want to make this national organization so strong that it will never again be necessary for us to confer day after day with labor leaders to obtain our rights.

"If a man is not a union member and is loyal to you, you must be loyal to him. We must be able to obtain liberty in every sense of the word, and not merely privileges. The conditions are disgraceful which make it necessary for us to consult with our employes at every step."

Contractor William Grace, of Chicago, declared that he was tired of being told what to do by Gompers and Mitchell and other labor leaders.

Mr. Grace declared that the running of the United States' mail cars without police protection during the recent strike had made him think that his rights and the rights of every American citizen were just as sacred as the mail cars.

By other speakers, all the troubles of the builders were laid at the door of organized labor. The feeling for the "open shop" was strong.—*"Keith's Magazine."*

A cotton picker machine has been invented which, it is claimed, will save one-third of the crop and the wages of twenty-eight men.

Last year 5,723 miles of new steam railway track were built in the United States. That was thirty-nine miles more than the total mileage constructed in 1902.

Cramps Draftsmen at Dinner

Draftsmen employed in the several departments of the Cramp Shipyard, Phila., Pa., had their annual dinner Friday evening at the Hotel Garrick, where covers were laid for 50. Axel Russell acted as chairman and the speakers were J. W. Rhoder, W. C. Nickum and W. H. Rogers. The committee in charge of the affair consisted of W. A. Leavitt and W. K. B. Potts.

A Common Mistake.

OUR bright and able contemporary, "The Draftsman," has introduced a department for "Home Study," and its first series of articles is "A course in Elementary Mechanical Drawing," which contains many good practical hints. But we were a little surprised when we read the following passage, coming from such a source:

"The T-square should be used for drawing horizontal lines only. Its head should always be placed upon the left edge of the board. Vertical lines should be drawn by the use of a triangle placed upon the T-square and not by means of the T-square only; because the edges of the blade of the T-square are often not at right angles to the head, so that lines at right angles to each other will not result from the use of the T-square upon all edges of the board."

Now the fact is that it does not make the slightest difference whether the blade of the T-square is, or is not, at right angles with the stock or head. The relation of horizontal and vertical lines to each other, so far as being at right angles to each other is concerned depends wholly upon the corners of the drawing board and when the T-square is applied consecutively to the left hand and under edges of the drawing board, the direction of the lines then drawn is governed by the lower left-hand corner. If that be a right angle, the lines will be at right angles to each other, whether the T-square is a true square or not.

The idea that the blade of a T-square must be exactly at right angles with the stock is a very common one, but it is a mistake nevertheless, as a very little reflection will show to those who have a slight knowledge of geometry. The subject was discussed very fully in our issue for June. As for using the T-square for drawing vertical lines, that is often necessary, and there can be no objection to doing so provided the drawing board is right. At the same time every draughtsman knows that for vertical lines, of ordinary length, the set-square is the most convenient tool.

It is easy to test the truth of our statements by using a square with a movable head or a bevel-square, as it is called. Let the blade of such a square be set so that it is obviously not at right angles to the head and then draw vertical and horizontical lines by means of it. Test these lines by any of the well-known geometrical constructions, and if the corner of the drawing board is a right angle the lines will be found to be at right angles to each other. This is the most accurate and simple method of testing a drawing board. To test the square itself when it is made as directed both by "The Draftsman" and "Self-Education" is not such a simple matter and would require more space than we can afford for this note:

"The Draftsman" is usually so accurate and its directions are so judicious that the above lapse is all the more extraordinary, but we have had similar accidents happen to ourselves over and over again."

The above is quite true and the writer of the part from The Draftsman admits that that is not as well expressed as it should have been, so we feel grateful to the editor of Self-Education for the attention given it. So we will say "The T-square should be used for drawing horizontal lines only. Its head should always be placed upon the left edge of the board. Vertical lines should be drawn by the use of a triangle placed upon the T-square and not by means of the T-square against the lower edge of the board, because the corners of the board are often not at right angles with each other.

Promoted Draftsman.

Albert J. Stibolt has been appointed by Colonel J. L. Lusk to the position of chief draughtsman in the office of the Government Engineer's office in this city, succeeding to the vacancy occasioned by the death of Henry P. Bosse. The promotion, which carries with it a neat increase in salary, is a deserved one, Mr. Stibolt having served the government for a quarter of a century.—*Rock Island, Ill., Argus.*

Every man has two educations—that which is given him and the other that which he gives himself. Of the two kinds, the latter is by far the more valuable. Indeed, all that is most worthy in a man he must work out for himself. It is that that constitutes our real and best nourishment. What we are merely taught seldom nourishes the mind like that which we teach ourselves.

JOHAN PAUL FREDERICK RICHTER,
(Eighteenth Century.)

Photography Without a Camera-Copying Drawing.

For copying small but elaborate drawings like Patent Office drawings there is probably no method so quick, accurate and cheap as the following, says a writer in *American Machinist.*

Procure a photographic dry plate of the size required (8x10 is usually large enough for Patent Office drawings, the rest of the sheet being taken up by margins, title and signatures). Place the drawing and plate in a printing frame, the drawing with the back side out, so that the lines will be in contact with the film on the plate. This must be done in a dark room. Expose the frame to dim daylight for a period of, say, five seconds at a distance of about 10 feet from a north window or one through which the sun is not shining. Develop with the following:

No. 1. Hydrochinon Solution.—(a) Water, 13 ounces; sulphite soda crystals, 1 ounce. (b) Water, 2 ounces; sulphurous acid, ½ ounce (not sulphuric).

Add solution (a) to (b) slowly, then add: Hydrochinon, 100 grains; bromide potass., 30 grains.

No. 2. Alkali Solution.—Water, 5 ounces; carbonate soda (dried), ½ ounce; carbonate potass. (dried), ½

A beehive coke oven, in full blast during the world's fair, will be one of the exhibits presented by Kentucky. The Blue Grass state has 6,000 square feet of floor space in the palace of the mines and metallurgy.

Draftsman Named.

MEN APPOINTED TO POSITIONS IN THE DEPARTMENT OF INTERNAL AFFAIRS.

W. M. Mooie, of Clearfield, and C. Templeton Ritter, of Allentown, have been appointed draughtsmen in the department of internal affairs and ordered to report for duty next Monday. The last Legislature appropriated $20,000 for the employment of additional draughtsmen in this department, and Secretary Brown has appointed eignt altogether.

There are numerous applicants for these positions, but the secretary has decided to make no addition appointments unless there should be vacancies. —*Harrisburg Dispatch.*

What he Says.

The Draftsman.—Your persistency in sending me sample copies of "The Draftsman" has finally convinced me that it is a splendid little publication, and enclosed you will find check for one year's subscription to still help it along to further success.

Very truly yours,
W. NEVIN FLICKINGER.

Mr. L. E. Woglemuth, heretofore chief draughtsman of the Chicago, St. Paul, Minneapolis & Omaha, has been appointed mechanical engineer, with office at Saint Paul, Minn., to succeed Mr. B. R. Moore, who has been appointed assistant superintendent of motive power and machinery, with headquarters at Sioux City, Ia., succeeding Mr. F. M. Dean, resigned.

Chief Draftsman to Go.

W. G. COREY FOLLOWS APPLEYARD FROM CONSOLIDATED'S CAR DEPARTMENT.

Following upon the retirement of Master Car Builder W. P. Appleyard from the car department of the Consolidated Railroad, which office it is said will be abolished, came the announcement to-day that Wilbur Graham Cory, the chief draughtsman and mechanical engineer in the same department had resigned.

Mr. Cory is a well-known resident of New Haven. He was educated at Washington University, which he left in 1888, entering the service of the Pullman Company at the St. Louis shops. He was with that concern engaged in his line of work until 1895, when he became supervisor of drawing room and sleeping car repairs on the Consolidated Road. Since 1896 he has been chief draughtsman and mechanical engineer on the road.

He has many friends in this city. His term of service with the road ends Saturday.

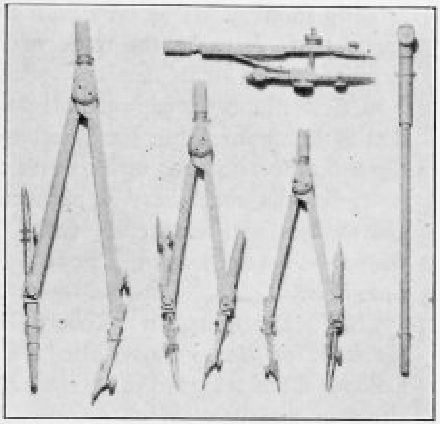
Editor The Draftsman, Cleveland, O.:

Dear Sir:—Referring to your geometrical problem in the December number, the arc A K as shown in the figure cuts the line B K a little short of where it should. With a radius A B and center at B the line A K would be longer than shown and the lines E K and C E would not be equal. Then the angle C D E would not be equal to the angle B E K and the angles K B D and B D C would not be equal.

Yours, etc.,
M. C. HURD.

Duplex Instruments.

The illustration shows clearly the make-up of the Duplex Drawing Instruments handled by Mr. N. A. Newton, 114 Central Ave., Oil City, Pa., and it will be seen that each instrument has many good qualities.



The compass on the left of the illustration is provided with a lengthening bar as shown on the right and will answer for quite large circles.

The second instrument from the left is arranged with lead, a pen and two points which allow it being used as a pair of dividers.

The next one is simply the compass with lead and pen point and is not arranged for extra bar. The top instrument is what is commonly called bow-pen and pencil and is very neat and convenient.

The instruments are well made and highly finished and are great time savers, and are just what a rapid draftsman should have to aid him in his work.

For further information about these instruments, write Mr. Newton.

An unrecorded occurrence of last Friday is brought to light by the presentation to B. J. Carnes, draftsman of the state land office today, of a leather medal in the shape of a shield on which is inscribed: "To B. J. Carnes for Saving the Life of W. H. Pierce."

Mr. Pierce is employed in the secretary of state's office, and rooms at Mr. Carnes' residence, 406 Pine St., S. Mr. Carnes was awakened about 3 o'clock last Saturday morning by the smell of smoke. Investigating, he found the source of it was the room in which Mr. Pierce was sleeping. A lamp which Mr. Pierce was accustomed to leave burning all night was giving off the fumes which made the bed-room look like the top story of the most wicked place. The householder lost little time in getting his roomer out of his slumber and his room. Mr. Pierce was quite sick and has not yet gotten over the ill effects of the occurrence.

Everyone in the land office has heard about Mr. Carnes' medal, which is cleverly made.—*Lansing (Mich.) Republican.*

Two city jobs were handed out yesterday. Lloyd Moffat is appointed a draftsman and Henry Martin is made a machinist in the water department. —*St. Louis World.*

Erith's Engineering Company, London, have got possession of an automatic stoker as a specialty, and as it is certain to come largely into use, it will effect that great improvement in smoke consumption and fuel economy which has been so long desired.

Photography without a Camera.

(Continued from page 183)

ounce.

To develop, mix 3 ounces No. 1 with 1 ounce No. 2.

If the exposure has been correct the development will proceed slowly until the background is as black as ink, the lines remaining clear white in the negative. Fix and wash as usual. Brilliant blue prints may be made from these negatives, showing sharp blue lines on a white ground.

W. H. S.

Electric Bolts in War.

To destroy armies by lightning is thought by Emile Guarani, a French writer, to be a possibility. Receiving a shock from a wireless telegraph apparatus through an umbrella, he experimented with a Ruhmkorff coil, and found that shocks could be transmitted through the air with moderate currents. He concludes that the energy of 1,000 horse power, at 100,000 volts, could be concentrated by antennae so as to destroy life at a distance of 12 miles. The present difficulty, which he believes will be soon overcome, is that of controlling and directing the electric waves.

I have taken your magazine from the first number and find it one of the best I have ever seen for practical everyday "hints" and information in detail on all subjects pertaining to the drafting table.

C. R. Miller, Galion, O.

Personals.

Franklin Farrel, Jr., the son of a Connecticut millionaire and a recent graduate of Harvard, has entered his father's foundry at Derby with the purpose of learning the trade of a foundryman in all its details.

H. C. McCann has resigned his position as draughtsman in the Wisconsin Central offices to take up a course of study in the machinery department. His position will be taken by Garth G. Gilpin.—*Commonwealth, Fond du Lac, Wis.*

Chief Draughtsman Robert D. Coombs, of the Pennsylvania Steel Company, has resigned to accept a position as assistant bridge engineer of the New York, New Haven & Hartford Railroad Company. Mr. Coombs' successor will be E. T. Holler, who was formerly chief engineer of the American Bridge Company's plant at Pencoyd.—*Philadelphia Press.*

WINNER.

Two young men are making a fortune in New York City taking contracts to polish tarnished gas fixtures. The following is the recipe of the metal polish which they make and use:

Muriate of ammonia . . 4 drs.
Oxalic acid . . . . 1 dr.
Vinegar . . . . 1 pt.

Dissolve the oxalic acid first, when mix all and apply with a soft brush, having work clean and bright.

Dear Sir:—Your favor of the 27th to hand for which please accept my thanks. I was much pleased to note that you accepted my print and more so that you entered my name on your subscription list. I would ask that you please send me some sample copies of your February issue as I think I can do some business for you. Please start my subscription with the Jan. issue.

A little "kink" comes to my mind in reference to cleaning a tracing of pencil marks, dirt, etc., without injuring the ink in the least, which I think is not genally known and therefore would be very useful to the readers of "The Draftsman."

It is as follows: Take a piece of cloth, saturate it with benzine and wash the tracing. If you can make use of it, would be pleased to have you acknowledge it.

Anything I can do for the success of "The Draftsman," will be pleased to do it.

Thanking you once more for past favors, I remain,

Sincerely yours,

JOHN GRAHAM, JR.

Dear Sir:—Accidently I got hold of a copy of your "Draftsman" and must say I like it very much and would like to have you send same for one year to me under above address. Enclosed please find one dollar.

I would like to hear from you also if you have single copies of 1902 and 1903 yet, and how much you charge for same.

Hoping to hear from you soon, I am, Respectfully,

VICTOR R. A. STROH, Ch. Dr.

L. H. Yeager and Charles G. Tice have returned from a trip to Baltimore.

Claude Mengel, draftsman with Ruhe & Lange, architects, and Miss Helen Kopp, of Reading, will be married next Wednesday by Rev. Dr. B. Bausman.—*Allentown (Pa.) News.*

Chicago, Feb. 12, 1904.

Dear Sirs:—Enclosed please find money order for one dollar, for which renew my subscription for one year.

I have enjoyed reading it for the past year and have found it very useful, and it is getting better all the while.

Wishing you success, I am,

Sincerely,

H. W. GOODENAU.

Chicago, Feb. 15, 1904.

Dear Sir:—Enclosed find 10 cents in stamps for which please send me a copy of the "Handy Lumber Tables."

Every one of the boys seem to feel that "The Draftsman" has no equal. It certainly fills a long felt want.

Wishing you success, I am,

Yours truly,

J. HERBERT HOPP.

Herbert A. Wright, draughtsman at the Fauber factory, and Miss Marie T. Hylen, for the last eight years an employe of the watch factory, were united in marriage December 31, at 1468 Halsted street, Chicago. Rev. John Thompson, of Grace M. E. Church, performed the ceremony in the presence of twenty relatives and intimate friends. The bride and groom are well and favorably known to a large number of Elgin people, who unite in extending hearty congratualtions. Mr. and Mrs. Wright will reside at 227 DuPage street.

Books and Pamphlets.

Modern Wiring Diagrams and Descriptions for Electrical Workers tells how to wire for call and alarm bells. For burglar and fire alarm, How to run bells from dynamo current, How to install and manage batteries, How to test batteries, How to test circuits, How to wire for annunciators, for telegraph and gas lighting. It tells how to locate "trouble" and "ring out" circuits. It tells about meters and transformers. It contains 30 diagrams of electric lighting circuits alone. It explains dynamos and motors; alternating and direct current. It gives ten diagrams of ground detectors alone. It gives "Compensator" and Storage Battery installation. It gives simple and explicit explanation of the "Wheatstone Bridge" and its uses as well as volt-meter and other testing. It gives a new and simple wiring table covering all voltages and all losses or distances, etc., etc. 160 pages, over 200 illustrations, Full Leather Binding, Round Corners, Red Edges, Pocket Size 4x6. Price, Net $1.50. Published by Frederick J. Drake & Co., 211-213 East Madison St., Chicago, Ill.

A greatly enlarged edition of "Hand Book on Practical Mechanics" has appeared.

This pocket book manual contains answers to tough problems and questions that come up every day in the machine shop and drafting room, and they are all figured out by simplest methods in arithmetic. There are also to be found more practical reference tables than are contained in all the so-called Mechanic Hand Books bound together in one volume. Many tables and valuable shop "kinks" are taken right from note-books of the best mechanics in the country. This book is published by Charles H. Saunders, 216 Purchase St., Boston, Mass. Price, post-paid, $1.00 in cloth, $1.25 in leather with flat.

Engineers and Surveyors.

TABLE BOOK.

This neat leather-bound book contains table of Logarithims of numbers, Logerthimic, Sines and tangents, national sines, cosines, tangents and cotangent, traverse table, squares, cubes, square and cube roots, circumference and areas of circles, etc., all well arranged and printed. There are 18 pages, 3¾x6½ in., price $1.50. The book is published by the Wm. E. Stieren Co., 544 Smithfield St., Pittsburg, Pa., who will give further information.

The catalogue of Federal Blue Printing Machines show apparatus for making blue prints by very convenient and rapid method. Without the use of plate glass in the front. The Spaulding Print Paper Co., 44 Federal St., Boston, Mass., as the main factories.

The Velocity of Radium.

The latest wonder of science, radium, is now believed in some quarters to be the substance of which the sun is composed. Light travels at the rate of 186,000 miles a second. Considering that the brain can scarcely grasp the speed of a bullet, a mere 650 yards a second, it is readily seen how far beyond human comprehension is such a speed as this. Nor is it any easier to grapple intelligently with the speed of the emanations of radium, some of which fly off at a velocity of 120,000 miles a second, and will penetrate steel and various other substances as easily as smoke will pass through muslin. So powerful are these rays that it would be as dangerous to approach radium in any quantity as it is to go near gunpowder with a lighted match. A man entering a chamber containing a pound of radium would have his eyesight destroyed, his skin burnt, and would probably lose his life.

Artificial Building Stone.

Houses of sand, as substantial as granite, are offered by the new process of Mr. L. P. Ford, of Gresford, England. A mixture of sand and quicklime in suitable proportions is forced into a very strong steel mold, which is placed in a box, from which the air is then pumped, when hot water is admitted. The heat and pressure of the slacking lime and steam mold the materials into a rock having 60 per cent. of the strength of granite. This building stone, ready for use in eight hours, is very durable, and its cost is low, bricks by this process costing little more than half as much as the ordinary.

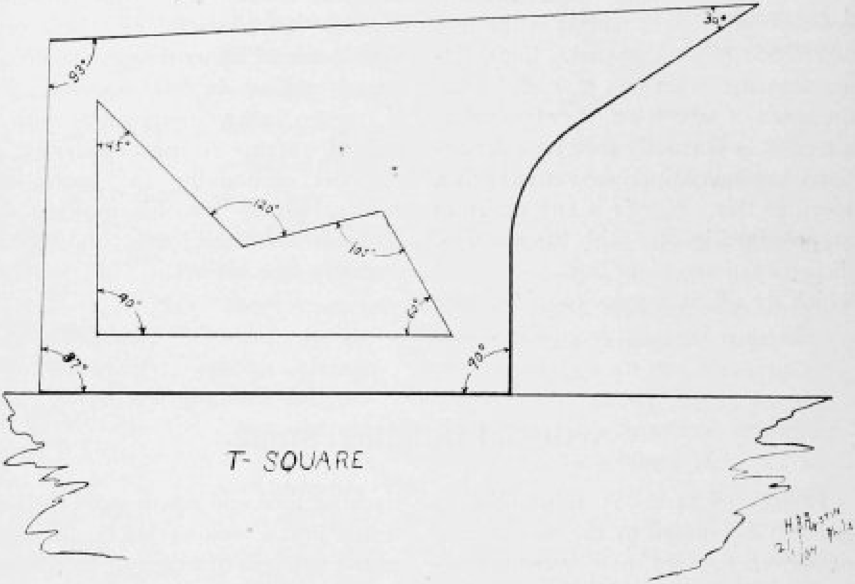
Improved Steel Castings.

For producing steel castings free from blow-holes, M. Meslan advises adding an alloy of aluminum and calcium to the molten metal. He has found that the combination of these two metals absorbs all gases present.

A Handy Triangle.

With an odd piece of celleloid one can make a very handy triangle if it is cut to the shape shown.

Mr. Austin, a reader, offers it as a sample of what can be made from the scraps of larger triangles, or from other material.



A Drawing Title.

A variety of neat lettering is shown in the accompanying illustration of a title for a drawing.


VEST
POCKET
LOOSE-LEAF
MEMO.
BOOK
PRICE
50
CENTS

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

A High School Drafting Room.

(BY E. A. RHODES.)

Fig. 1 shows a modern high School drafting room that for fitness of purpose, I beleave is not excelled by any similar school. The room is 22 feet wide by 45 feet long and 15 feet high. It is lighted by large windows on left side of students. There are 45 drawing tables, adjustable for height and angle and may be rotated. The student may stand or sit as he may prefer or as may be required by his drawing. The tables each have a round base and a foot rest. The seats have rubber tips to permit their being moved without much noise. Each drawing room table is provided with a drawing-board, a tee-square, a 45° and 60° triangle, curved ruler, scale, writing-pen, and bottle of drawing-ink. There are two sets of lockers, like the one shown at the rear of the room for holding supplies,, finished work, etc.

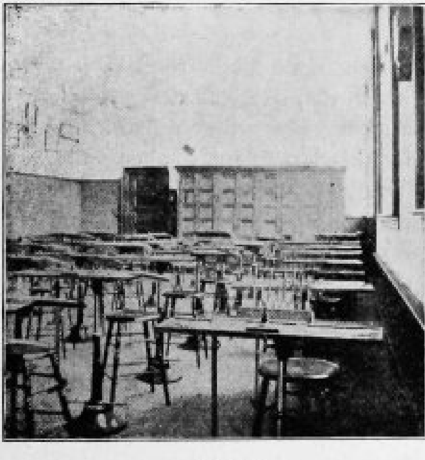


Fig. 1.

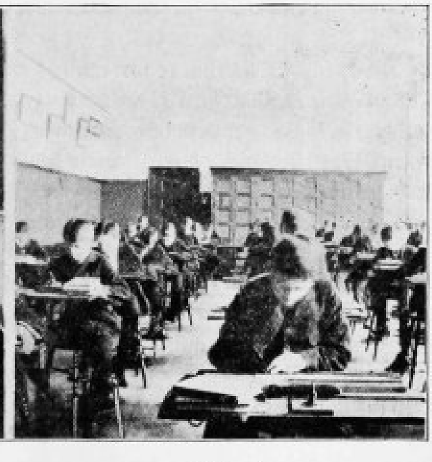


Fig. 3.

After much thought, it was decided to try as an experiment, to have the several students that use the same drawing-table use the same drawing board.

Our object was to dispense with a large rack holding about 400 drawing-boards and incidentally to have less noise when changing classes. The scheme is worked out as follows: There are five rows of drawing tables, nine to the row, and usually six classes each day. For each row of tables, one boy for each class is appointetd to distribute the unfinished drawings as the class enters the room. The same boy collects the unfinished drawings at the end of the drawing period. The time required for a class to receive its papers and start work is not more than one, or sometimes two minutes. To collect the papers and for the class to get ready to leave the room requires about two minutes for a class of forty students which is much less than was required by the old plan of each boy having his own drawing board.

The school also provides drawing pencils and erasers. We have found the best plan was to provide blocks like figure 2, one for each row of drawing tables. These blocks have holes for as many pencils and erasers as there are drawing tables in the row (nine). The boy that works at No. 1 table has charge of the pencils and erasers for his row of tables, he distributes them immediately upon entering the room, and collects them the last thing before leaving it. For the drawings of the manual training lessons (wood and iron) we use paper 7½"x10" and 10" x 15". For larger special drawings, we have boards to which the drawing paper may be fastened until the drawing is finished. For the two smaller sizes, we usually use but two thumb tacks, one in each of the upper corners of the sheet. To collect the papers, we ring a warning bell two minutes before time for class to leave the room, immediately each boy stops drawing, takes out his thumb tacks and the drawing pencils and erasers are collected by those in charge of the row, starting at number 1, then collecting at No. 2, No. 3, and so on. When collected, they are placed upon the front tables from which they are collected and placed in a locker where they remain until time for the class to again take up the work. The tee-squares hang under the desk in a position easily reached and on a hook so shaped that the tee-square will slip off before the blade will split. Not many of the students spill ink because the ink bottle is never removed from the stationary block provided for it on the front of the drawing table.

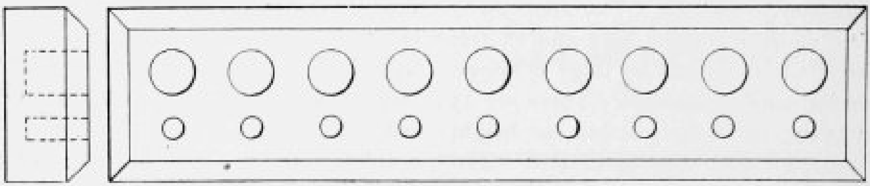


Fig. 2.

Fig. 3 shows a class of first year boys at work, an interesting feature of this picture is the boy in front moisting his pencil to lay off a measurement, a habit that sometimes requires considerable effort to overcome.

MECHANICAL.

The Cylinder Design of a Compound Engine.

By Robert R. Abbott.

IN correctly designing a compound engine, two things are of fundamental importance: First, the work done in the H. P. and L. P. cylinder should be nearly equal. Second, the total initial pressure on each piston should also be nearly equal. We will consider here a method for correctly designing a compound engine, considering only these two points.

Let us assume the following data for an example:

Non-condensing engine,
Steam pressure 160 lbs.
Releasing at 20 lbs.
Back pressure 16 lbs.
All pressures absolute.

This will give us 8 expansions since

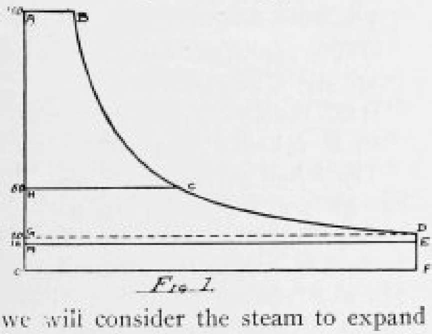


Fig. 1.

we will consider the steam to expand isothermally, that is at a constant temperature. We will now draw the combined theoretical indicator diagrams, considering the volume of steam at cut off as one cubic foot. This diagram is given in Fig. 1. The figures at the left are the pressures.

The work done by the steam in both cylinders is represented by the area ABCDEM, and our problem is to divide this area by a line parallel to EM such as HC, which shall represent the receiver pressure and at the same time make the area of the two parts of the diagrams practically the same. To begin with, substitute in the formula:

$$\log \frac{V_2{}^2}{E} = \frac{1 - \frac{P_4}{P_1} E}{2.3026}$$

in which V_2 is the volume represented by the line HC, our required line. P_4 is the back pressure, P_1 is the admis-

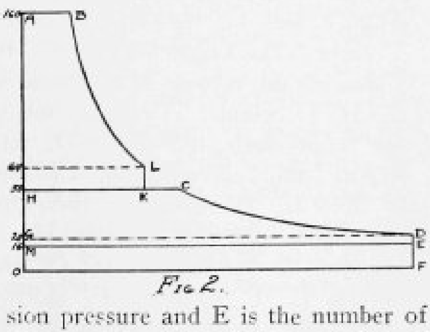


Fig. 2.

sion pressure and E is the number of expansions. If you have a table of hyperbolic Logarithms, the formula can be used without the 2.3026. This substitution gives us the following:

$$\log \frac{V_2{}^2}{8} = \frac{1 - \frac{16}{160} 8}{2.3026} = .08682$$

The number corresponding to the log. .08682 is 1.1221, our formula therefore becomes $V_2 = 3.13$. The pressure corresponding to this volume is now obtained by dividing our boiler pressure by it; this gives us 51 lbs. This means that in order for both cylinders to do the same amount of work, the receiver pressure should be 51 lbs., considering the H. P. cylinder to release at receiver pressure, but since this would not be practicable, let us draw the line HC, Fig. 1, through the 50 lb. line; the reason will be shown later.

Let us now turn our attention to the initial pressures. The initial pressure is either cylinder tending to move the piston would be the net steam pressure multiplied by the piston area; if the stroke in both cylinders is the same the two piston areas would have the same ratio as the volumes of the cylinders at release, so if we multiply the net pressure in either cylinder by its respective volume, the product will be the relative initial pressure. The length of the line HC represents the volume of the steam in the H. P. cylinder at release, and to the same scale the line GD. represents the corresponding volume in the L. P. cylinder, therefore, the initial pressure in the H. P. cylinder is $110 \times 3.13 = 344.3$; and in the L. P. cylinder is $34 \times 8 = 272$. Our initial pressure in the H. P. cylinder is evidently too high; this can be decreased by decreasing the piston area and consequently the volume. Divide the 272 by 110 and we get approximately 2.5, in other words if the volume in the H. P. cylinder at release is 2.5, the initial pressure would be nearly equal. The pressure corresponding to the volume of 2.5 is $160 \div 2.5$, which equals 64. We will now draw another card for these new conditions. It will give us a diagram similar to Fig. 2.

It is apparent that to make the initial pressures equal, we have had to cut the triangular part LKC from the H. P. cylinder work diagram, however in the first place we purposely drew the line HC slightly lower than it should be in order to allow for this.

The work in the two cylinders is now proportional to the areas ABLKH and HCDEM. We will find these relative areas by substituting in the formula: Area $= P. V. \left(1 \times 2.3026 \log \frac{V_2}{V_1}\right) - P_2 V_2$ in which P_1, V_1, and P_2 V_2 represent the pressure and volume at cut-off and release respectively.

H. P. area $= 160\ (1 + 2.3026 \log. 2.5) - 50 \times 2.5 = 181.6$.

L. P. area $= 160\ (1 + 2.3026 \log. 2.556) - 16 \times 8 = 182.1$.

The work done in either cylinder is evidently practically equal. Let us see about the initial pressure.

H. P. cylinder $= 110 \times 2.5 = 275$.

L. P. cylinder $= 34 \times 8 = 272$.

The initial pressures are also close enough for practical purposes.

Our engine would therefore be made with a cylinder volume ratio of 2½ to 8, cutting off at 2/5 stroke in the H. P. and about ⅜ stroke in the L. P. cylinder, releasing at 64 lbs. in the H. P. and 20 lbs. in the L. P. cylinder and having a receiver pressure of 50 lbs.

Reclaiming Waste Flue and Furnace Gases.

By George E. Walsh.

THE fuel saved by means of economizers and the utilization of flue and furnace gases in the gas engine represents in the aggregate an enormous amount of energy in this country. The production of electrical energy by means of the latter process is already carried on a scale so great that it represents a new group of industries capitalized into the millions. But even these accomplishments are small in comparison to what may be expected in the near future when the gas engines of small and large units are distributed throughout the iron and steel sections of the country in sufficient numbers to meet the demand.

It has been generally claimed that so valuable is the waste blast furnace gases considered when burnt in the gas engines that the production of pig iron will become of only secondary importance. That is, the blast furnace plant will be far more useful and profitable in producing electrical energy for manufacturing purposes than it has been in the past in making pig iron. If a plant producing 150 tons of pig iron furnishes 21 million cubic feet of gas per day, it is quite apparent to all that as a gas generator it certainly is a remarkable plant. This enormous amount of gas was formerly little used. It represented waste energy which could not be satisfactorily harnessed. Blast furnace gas is very poor compared with commercial gas manufactured for city uses. Its average is less than 28 calories per cubic foot. It did not seem possible that this gas could be utilized in any sort of engine. Consequently the only part of the waste gas reclaimed was that used for heating the air-blast of the furnace. This to some extent introduced economy in the manufacturing of pig iron.

The waste gas has been used to some extent to heat the boilers of steam engines, but only very ineffectually. To illustrate the difference between the two, if the 21 million cubic feet of waste gas is employed to heat the boilers of steam engines not more than 2,000 effective horse-powers could be obtained thereby; but when burnt in the gas engine about 7,000 horse-power can be produced. Where about one-half the waste furnace gas is used for heating the air-blast for the furnace there is still left a sufficient volume to produce 3,500 effective horse-power by means of the gas engine.

Fuel saving by means of the economizer is still employed in many plants, and more attention is given annually to the waste flue gases of an ordinary mill or factory. In such an ordinary furnace it is estimated that the pound of coal when burnt to evaporate nine pounds of water will at the same tim release twenty-one pounds of fuel gas. This gas escapes up the flue, and must either be reclaimed or used to heat the water in the economizer. When the gas goes up the flue its temperature is about 600 degrees, but it is reduced in the economizer to about one-half or 300 degrees. In losing half of its temperature the total amount of gas from the pound of coal gives up 1,512 British thermal units. If this amount of heat could be utilized directly for heating the water it would be found that the nine pounds of water could be raised to a temperature of sixty-eight degrees. This all presupposes a perfect burning apparatus, and also the utilization of every heat unit from each pound of gas. But the fact is we seldom can reach such perfection. In practical operation we can rarely save more than 1,200 of the 1,512 heat units released. If we accept the value of the coal to be 13,000 British thermal units, this would be a saving of 9.4 per cent.

Another method of reclaiming the escaping gases in an ordinary flue is to use them for preheating the air before it is admitted to the fire. This method has proved economical in many mills where every heat unit is of some special value. The high temperature of the gases in the flue are reduced in this way from 600 degrees to 250, and even to 150 degrees. The air itself which it is desirable to heat before entering the furnace is brought up to a temperature of 140 degrees by this method.

For the combustion of one pound of coal there is required twenty pounds of air. When this air is preheated before entering the furnace it will absorb 900 heat units from the hot gases of the flue. In this process it practically saves 7.4 per cent of the heat of the coal.

These two methods of economizing in fuel in the ordinary plant presupposes mechanical devices for driving the air blast so that the highest efficiency can be obtained. With forced draught of this nature the height of the chimney must be considerable. In plants where the feed water is heated by the exhaust steam, the use of the flue gas for preheating the air-blast adds greatly to the efficiency of the plant, and saves fuel sufficient to pay for the extra cost of the appliances in a short time. Another consideration to be remembered is the character of the feed water of the boiler. If this is full of impurities which will endanger the life of the economizer by depositing sediment and foreign substances in the tubes, it is unwise to resort to this method of heating the water unless some mechanical means can be employed for purifying it. This is not always possible where the water contains large quantities of sulphur and other dissolved impurities. The use of the flue gases for preheating the air-blast is then more economical, and the employment of the exhaust steam for heating the feed water.

In all these different methods of economizing fuel by utilizing the waste gas for heating the feed water, perheating the air-blast for the furnace, or burning the gas in gas engines for generating electric power for transmission or for local auxiliary purposes, the fact is kept steadily in mind that we are gradually extracting from each pound of coal a larger percentage of heat units than ever before. The ultimate object must always be to save as many of the heat units unlocked from each pound of coal as modern mechanical appliances will permit. The method of accomplishing this end must radically differ in different plants. So much depends upon the size of the plant and surrounding conditions and circumstances that it would be difficult to establish more than general rules.

To the electrical engineer the utilization of the waste blast furnace gases for the generation of electrical power seems the most fascinating, for here is something which directly shows visible results on a large scale. The saving of a part of the heat units of the pound of coal in the ordinary steam plant employed for driving an electrical generator is not always so apparent. It takes a little study and figuring to prove it. The coal pile may not seem to diminish quite so rapidly, but it must be a long time before a large saving can be figured out. This is further less attractive because the initial installment of the auxiliary machinery stands warningly before the mind. In fact the installation of the economizers cost in investment from $10 to $13 per horsepower, allowing for attention to it, and the machinery for preheating the air-blast from $8.50 to $10, according to the size of the plant. It is not easy to induce the owner of a plant to make such investments unless the saving is absolute and clear.

The utilization of the blast-furnace gases in the gas engine on the other hand is a most apparent saving, and one that appeals to all. Here the engine is burning what was formerly waste, and the power generated represents absolute gain. It is much like operating a machine by means of air or water. There is no fuel pile, no cartage or handling. After the apparatus is once installed for reclaiming the gas, cleansing it of impurities, and carrying it to the gas engine, the work is complete, and the gain evident to the engineer or owner as he daily watches the generation of the electrical power. The application of the gas engine to burning the waste gases of the blast furnaces is consequently building up in the iron and steel regions of Pennsylvania electrical industries second only to those on the line of the Niagara current.

Pneumatic Tubes in Boston

By E. D. Sabine.

THE Pneumatic Tube as a carrier of telegrams and single letters has been in use in England and Europe for many years. As a system for carrying messages and as a substitute for cash boys in our large stores and office buildings, it is a familiar object in the United States. However it was only ten years ago that the Post Office Department of the United States adopted this system for the quicker transportation of mails. During the winter of 1892-93 there was laid in Philadelphia, a line of six inch cast iron pipes bored out on the inside and connected with unique machinery for the handling of the carriers. Four years later this system was extended in Philadelphia and introduced into New York and Boston. The new lines however were eight inches in diameter, more than doubling the capacity of the system. In 1900 and 1901, a ten inch system was laid in Boston. This was originally intended for parcel delivery, but in the fall of

1902, the Government rented it for Post Office use.

This is the largest system that has ever been in practical operation. The headquarters are in the building at the corner of Essex and Chauncey Streets directly at the head of Harrison Avenue, where a station of the Boston Post Office has been established. From here one line of tubes runs to the Back Bay Post Office, and another to the Roxbury Post Office and the South End Post Office on Washington Street.

The ten inch system differs from all others now in use in many respects. The carrier, which is the life of the system, is a departure from all existing forms. It consists of a cylindrical shell, 30 inches long, which is supported by a cast steel head at either end. These heads carry five pairs of lugs which support small drop forged steel wheels. These wheels are placed radially and are staggered so that those at one end do not follow in the track of those at the other. The carrier normally runs on two wheels at one end and one at the other, the extra wheels serving merely as guides, until the carrier changes direction or turns over a little when they in turn do the heavy work.

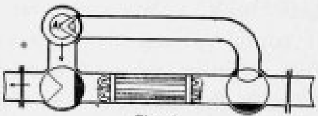


Fig. 1

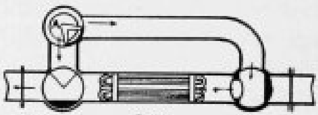


Fig. 2.

A door opening the full length gives access to the interior of the carrier. The capacity of a ten inch carrier is about a thousand letters as against six hundred for an eight inch, and two hundred and fifty for a six inch.

The tube through which the carrier runs is of cast iron pipe similar in design to ordinary water pipe. The bell end is counter-bored and the spigot turned so that a close fit is obtained at each joint, without shoulders or other obstructions. In casting the pipe special care was observed to secure a smooth surface inside, free from lumps and of nearly uniform diameter.

In laying the pipe an iron mandrel was passed through each joint in order to make certain of a perfect fit.

The tube was laid in a trench varying in depth according to the obstructions encountered in the street. Every piece of pipe was blocked from the undisturbed earth and wedged firmly into place. The joint was then tested with the mandrel and if satisfactory made up with lead as in water pipe. The joint was again tested and then another pipe set. In back filling, selected gravel well tamped was used to cover the pipe, and the excavated material was placed on that.

The bends are of cast iron, elliptical in cross section, and of twelve feet radius. These were used at street corners and in the buildings.

The terminals are of an entirely new design, radically differing from those used on the preceding systems. The receiver consists of a tee, compression chamber, and valves and cylinder to operate it. The air pumped in at the other end of the line passes through the tube underground to the receiver. There it turns down through the tee to a tank, from which the compressor at the end of the line draws its supply of air. This tank is open to the atmosphere and provided with racks on which calcium chloride can be placed to dry the air in wet weather. This prevents condensation in the tube and keeps the line dry. A carrier driven along by the current of air, comes to the receiver and passes through the tee into the compression chamber. Here it is brought nearly to rest by the compression of the air in front of it. It is found that in any line the carrier will roll to the same point of the receiver, whatever its load; but in different lines having different grades, etc., the point may not be the same. This point having been found by experiment, the receiver is adjusted to operate when the carrier reaches it.

The operation of the machine consists simply in opening the valve at the end of the compression chamber by means of compressed air in a cylinder. The carrier rolls out and as it clears the valve, the slight pressure of air behind it causes two vanes to spread apart and operate an auxiliary valve that causes the cylinder to close the main valve on the machine. The whole cycle takes less than five seconds.

The transmitter or sending machine is more complicated, as an entirely different problem is presented. The air at the beginning of its journey through the tube is at a pressure of some pounds above normal. This pressure is used in overcoming the friction of the air against the walls of the tube. To introduce the carrier into the current of air without interrupting its flow, some form of air lock must be used.

The method used is illustrated in the accompanying diagram which shows the principal valves.

The compressors used were built by the Rand Drill Company and are of the belt driven duplex type, with cylinders of twenty-four inch diameter and twelve inch stroke. They run at a hundred and fifty revolutions per minute. Both inlet and outlet valves are of the Corliss type, insuring high efficiency and smooth running. The normal running pressure varies with the length of line but is approximately three pounds. This gives the carriers an average velocity of thirty miles an hour.

The compressors are driven by five hundred and fifty volt three-phase induction motors of the internal resistance type. These motors were selected on account of their high efficiency under overload and their freedom from complicated parts.

The absence of commutator and brushes was a strong point in their favor. They have stood the strain of two years' running wonderfully well, there having been but one instance when the line has been shut down on account of trouble with the motor, and that was due to the carelessness of the operator.—"*The Tufts Engineer.*"

An apprentice course of instruction for draftsmen has been established by the General Electric Company at the Schenectady works. It is under the charge of Mr. J. W. Upp, and is intended to qualify applicants for work in the drafting rooms of the company.

Hook for Iron Breakers.

NEARLY every foundry uses scrap iron to mix with the pig in the cupola and the scrap must be reduced to handling size.

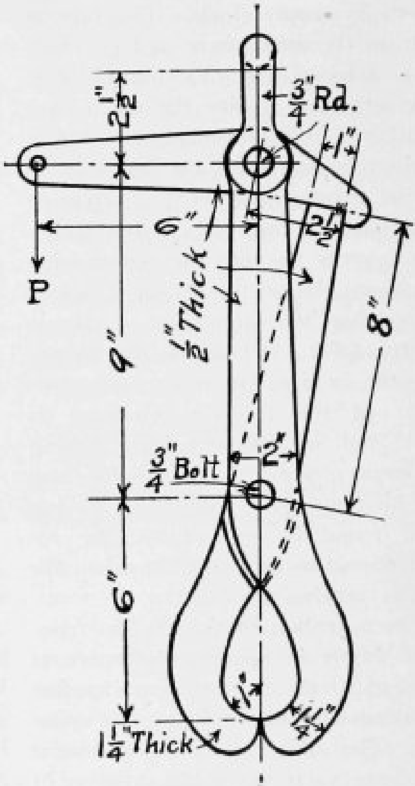
For this purpose, a breaker is erected, which in appearance resembles a well derrick with its windlass.

The illustration only shows the design of the hook for engaging the lift rope with the weight or breaker.

The weight may be of any shape from that of a sphere to that of a style used for driving piles. A weight of 500 to 600, with a lift of 25′ will do effective work.

To find the size of a casting ball to weigh 500 lbs, divide 500 by .26 which gives the cubic inches in the sphere = 1923.08. The volume of the sphere is equal .5236 d^3, then dividing 1923.08 by .5236 will have d^3 = 3672.8.

Extracting the cube root of 3672.8, we have 15.4″, which is the diameter of the sphere.

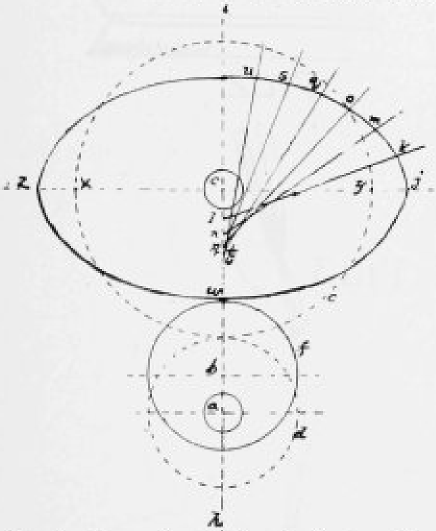


Elliptic Gear.

BY R. W. J. STUART.

I HAVE just had an experience in gear pattern making that is out of the ordinary, the case being a two-lobe elliptic driving a circular gear set on the shaft eccentric. Of course this method could only be applied where the eccentric or small gear revolved twice to the elliptic or large gear once. When this job came up, I was rather loath to undertake it, as I had made circular gears only heretofore, and upon inquiring among all the nearby pattern makers, I found that not one of them had ever done just such a job. Fig. 1 will give an idea of what the gears were like, and how I got about solving them. First I took the center a and c on which the gears were to run, and drew the pitch lines as they would be if both gears were concentric, then from the center b, I drew the pitch of the small gear as required in the pattern. The next operation was to draw the ellipse.

The points x and y being the two foci, and the points at which to stick pins for drawing the ellipse with a string. I tried the string but found that I could not get the ellipse as true as I wanted to, owing to the stretch in the string, so in order to get it right, I made the train shown in Fig. 2 of cigar boxes. The distance from y to j and from x to y being equal to ab, Fig. 1. Therefore, in setting the tramel the distance from the tracing point to the nearest guide block center should be equal to wc and from



the tracing point to the farthest guide block center equal to cj. The ellipse drawn, lay out pitch points, then to get the proper slant for the center lines of the teeth, set one leg of the dividers in the center c and the other in the tooth center j. With the radius dj, set in tooth center k, marking off the point l on the line wc. Join l and k, extending the line out beyond the pitch point k. With the same radius set at m, marking off p, m, n, o, q and so on. Set train and draw root and point lines. Lay off thickness of teeth on pitch, root and point line. Set the dividers for a radius equal to 1½ times the pitch and draw in faces and flanks. Our gear being elliptic, in-

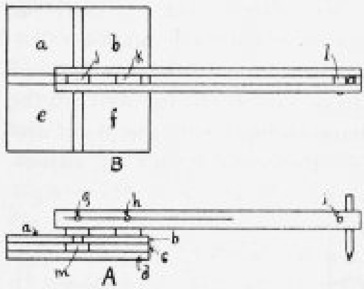


Fig 2

stead of circular and the teeth slanting, we will have to find the center with dividers for each individual tooth face and flank, so that the lines will pass through the points set off.

The patterns I made were for a heavy, coarse pitch, slow moving gears. I was surprised they worked so nicely. I have found that with coarse pitch gears, I can build up a blank and saw out the teeth on the band saw, setting the table, bevelling for draft having only to smooth them by hand. I believe the train may be used to transmit a limited amount of power, in which case it would take the place of gears of large diameter.

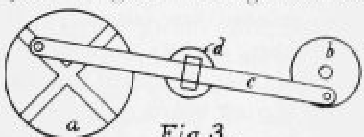


Fig. 3.

It would come in cases where the shafting are too far apart to use gears, and it is desired that one shaft turn in an opposite direction to the other, and make double the number of revolutions.

Drafting Wrinkles.

THERE are many little schemes that the draftsman of any experience runs across in his labors, and the following may be new to some of your readers.

They are simple, yet practical for every day use, what one wants.

How many times on a large piece of work have you been annoyed at the tee-square sliding onto the floor and probably throwing it out of adjustment thereby. If you are ever troubled in this manner, just fasten a small piece of rubber, slightly thicker than the blade of the tee-square, on the lower part of your board near the left edge, say 2" in and ½" up from edges. This will prove an effectual stop for the square, Fig. 1.

When taking a dimension off your metal scale, if you use one, how much quicker you could work if the divider or compass needle would stay where you wished it on the scale, instead of slipping off "just as you have it." Take a prick punch and make a slight dot at the extreme right hand mark on the scale both sides. See Fig. 2. When by placing the point in this slight impression, you have no fear of losing the place.

Again, how often could you save that penful of ink by passing it into the compass leg or other instrument. By opening the blades somewhat of the former and holding it over the closed blades of the latter, the ink will rapidly run from one to the other as shown in Fig. 3. Try it.

Another simple scheme for tilting the tee-square just enough for ruling screw threads, Fig. 4, is to cut a piece of wood as shown, to the angle desired and when in use is held in place by the fingers.

These little things are used by some of the best designers I know and are worth trying. DESIGNER.

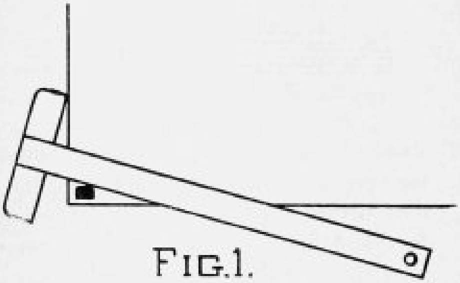


FIG.1.

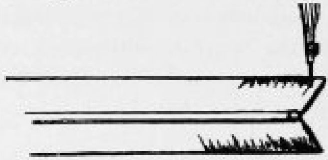


FIG.2.

FIG.3.

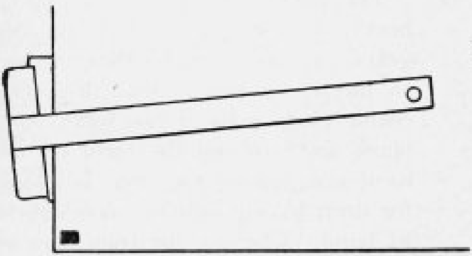


FIG.4.

The Tangent Circles.

Editor THE DRAFTSMAN.

Dear Sir: In the January number of THE DRAFTSMAN Mr. H. MacDonald gives a method of describing a circle tangent to three other circles. This is similar to a query which appeared a few years ago in one of the mechanical papers except that a formula was asked for finding the center of the circle; no one offered a solution.

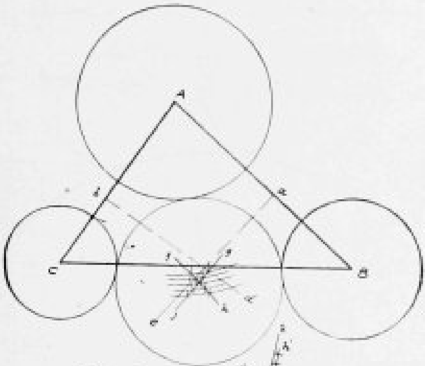


FIG 2

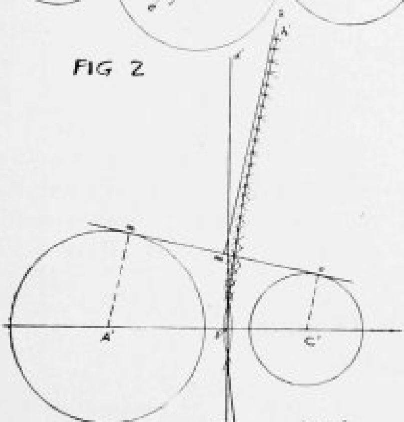


FIG 1

Let A′ and C′, Fig. 1, be any two given circles. Draw line f′b′h′ through the intersection of arcs which are equidistant from the circumference of A′ and B′. Then f′b′h′ is the locus of the centers of all circles which can be drawn tangent to A′ and C′. If continued this line would be tangent at infinity to the line "mk" drawn perpendicular to the tangent "no" of the two circles at its center "m." Where it crosses the line of centers A′C′ it is tangent the perpendicular d″d′ drawn at the point b′ half way between the two circumferences A′ and C′. To return to our problem, let ABC, Fig. 2, be the three given circles tangent to which we are to draw another circle. If we take two pairs of the circles and find the locus for each pair similar to Fig. 1, the intersection of the two loci will be the center of the required circle. It is not necessary to draw all of the line; only a short distance each side of the required center is all that is needed. Erect the two perpendiculars "ae" and "bd" at the middle points of the distances between the circles on the lines connecting the centers of the circles. Then the intersection "ae" and "bd" will be near to the required point. Then describing arcs equidistant from the given circles and drawing lines "gj" and "fh" through their intersections we find the center of the required circle at the point where the three cross. The solution given by Mr. MacDonald is not strictly correct, its accuracy depending on the relative sizes of the three given circles and also on the distance of these points "c" and "d" from "D." His solution gives the intersection of the tangents drawn to the two loci and the nearer the points of tangency are to the required point "D" the more nearly correct the solution will be. Also if the difference in size of the given circles is very great, the locus has very sharp curve at the beginning, so that in this case if his points "c" and "d" are some distance from "D," the circle can not be drawn tangent to the three given circles.

Yours truly,

F. W. SEIDENSTICKER.

Letter from a Draftsman.

Editor DRAFTSMAN: Noticing in your March number Mr. MacLean's construction of "To describe a circle tangent to three given circles whose

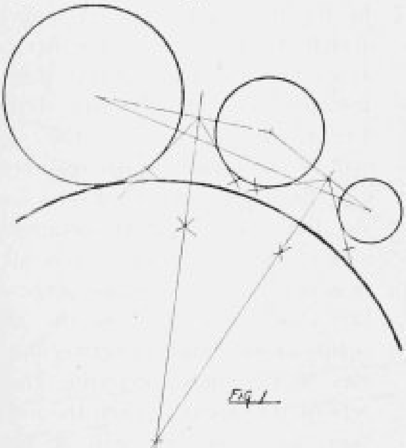


FIG 1

diameters are different, would say that while it would apply in some cases, its range of usefulness would be more limited than in the first construction.

For illustration, in Fig. 1 it will be seen that if circles happen in position shown, said construction would not work out as accurately as in first which is fairly illustrated in Fig. 2.

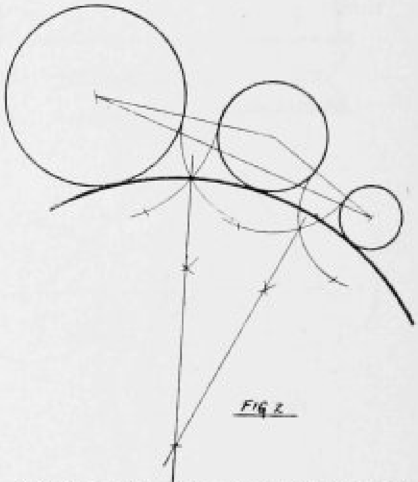


FIG 2

While neither is geometrically correct, they serve very well for laying out on a drawing to approximate the center. H. MACDONALD.

Machine Design.

EUGENE HIGGINS.

OFTENTIMES in designing machines and their details, it is impossible to compute the stresses in them. When a large and small machine have been carefully designed or built, the sizes of the details in machines of immediate capacities may be found by the formula $d_{,} = fc + i$ in which $d_{,}$ = the required dimension of a detail in the new machine.

c = the size or capacity of the new machine.

f = the factor.

i = the increment.

In the following formulas:

D and d = the dimensions of details in a large and small machine.

C and c = the sizes or capacities of a large and small machine

Let $d_1 = fc_1 + i$ (1)

$d = fc + i$ (2)

$D = fC + i$ (3)

Transposing (2) $i = d - fc$ (4)

Transposing (3) $i = D - fC$ (5)

Equating (4) and (5) $d - fc = D - fC$ (6)

Transposing $fC - fc = D - d$ (7)

Combining $f(C - c) = D - d$ (8)

Transposing $f =$ (9)

As an illustration of the above, it

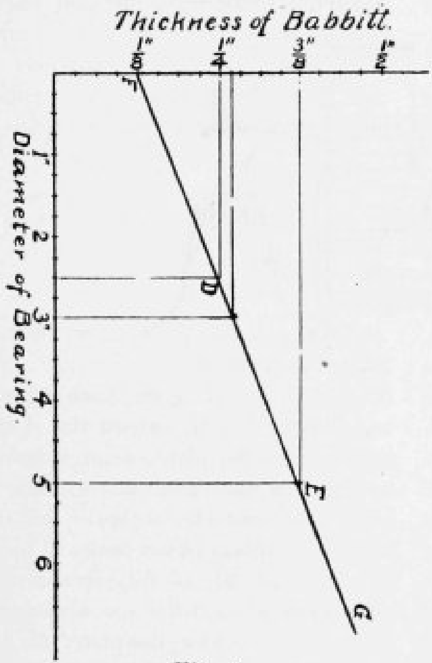


Fig. 1.

may be found from practice that the thickness of babbitt in a 5" bearing should be ⅜" and that in a 2½" bearing, it should be ¼" thick. What should be the thickness of babbitt in a 3" bearing?

In this case C = 5", c = 2½", D = ⅜" and d ¼". The factor may be found from (9)

$$f = \frac{D - d}{C = c} = \frac{\frac{3}{8} - \frac{1}{4}}{5\text{-}5\frac{1}{2}} = \frac{\frac{1}{8}}{2\frac{1}{2}} = \frac{\frac{1}{8}}{5\text{-}2} = \frac{2}{40} = \frac{1}{20}$$

The increment may be found from (5)

$$i = C - fC = \frac{3}{8} - \frac{1}{20} \times 5 = \frac{3}{8} - \frac{5}{20} = \frac{3}{8} - \frac{1}{4} = \frac{1}{8}''.$$

To find the thickness of babbitt of a 3" bearing, formula (1) may now be used,

$$d_1 = fc_1 \times i = \frac{1}{20} \times 3 + \frac{1}{8} = \frac{3}{20} + \frac{1}{8} = \frac{24 + 20}{160} = \frac{44}{160} = \frac{11}{40} = .275, \text{ say } \frac{9''}{32}$$

As f and i have been determined for the thickness of babbitt in bearings, formula (1) may be written $d_1 = \frac{c_1}{20} + \frac{1}{8}$ in which d_1 is the thickness of babbitt required and C_1 is the diameter of the shaft. All dimensions in inches. The problem may also be solved by the graphic method as shown in Fig. 1. Take a sheet of CUT No. 392.) cross section paper and lay off the diameters of the shafts on a horizontal line as "AB." Lay off the thickness of babbitt on a vertical line as "AC." The points "D" and "E" are at the intersection of the lines representing the diameters of the bearings and the corresponding thicknesses of babbitt.

Through these points, draw the straight line "F" "G."

Upon inspecting the diagram, the thickness of babbitt for any diameter of shaft may be readily found, as for instance, the thickness should be nearly $\frac{9''}{32}$ for a 3" shaft.

Subscribers Wanted in every drafting room and factory.

A Breeching for a Scotch Boiler.

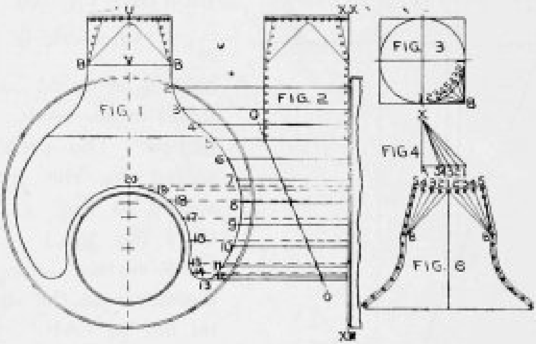
THE accompanying sketch shows a common form of breeching used in connection with the Scotch type of boiler and will no doubt be a good lesson for the students, or young men in the trade, who desire to become familiar with laying out of breechings. This is an excellent lesson, for the reason that the curve changes at nearly every point.

TO LAY OUT SUCH A BREECHING.

First strike up the diagrams, Figs. 1 and 2, and as the breeching is narrower at the bottom than at the top, strike the bevel line O-O, Fig. 2, which represents the line of cut-off. Now, starting at point B, Fig. 1, set your dividers about 2 inches apart, so that you will not lose by going around short curves, and mark the points 4 inches apart as denoted by points 2, 3, 4, etc., to 20. After these points are established, extend lines from these points over to the back line of breeching, which will be noted by X X, and X X. Please note that we have drawn dotted lines from the inner circle and solid ones from the outer curve, Fig. 1, so that you can readily distinguish the difference in the points of cut-off in Fig. 2. Now, with your dividers set at the same spacing as they were set when you divided up the circle or curves around the breeching, set off the same number of parts in Fig. 5 and number them the same from B to 20. You will note that all points were located about 4 inches apart, but at the bottom sharp curve they are spaced closer, or in other words, 2 inches apart, as this is necessary in all sharp curves if you are desirous of producing a perfect curve when sheet is rolled up and bent to shape.

Having located the lines on Fig. 5 from B to 20, using the back edge of breeching as A-B, extend the dotted lines across the plate of an indefinite length. In this case we are going to make the outside wrapper of the breeching in two pieces and will locate the seam at 20, as this is the most convenient place for it on account of rolling and working the plate.

Now take a strip of light band iron and lay on dotted line 20 and set one end on line X X, Fig. 2, then mark the point where the slope line O-O strikes line 20 and carry this measurement over to Fig. 5 and mark this distance from A to 20. Now take the strip back to Fig. 2 and take the length of



all the dotted lines from X X, X X, to O-O, as 19, 18, 17, 16, 15 and 14, and transfer these measurements to Fig. 5 from line A. B. Mark off point 19, 18, 17, 16, 15 and 14 and lines drawn through these points will give the curve of the inner circle.

Now take the strip back to Fig. 2 and lay it on the solid lines from line X X, X X, and mark all the points for the outside curve as 13, 12, 11, 10, 9, 8, 7, 6 and 5; then transfer them to Fig. 5. Then a line drawn through these points will give the required curve. As the breeching is straight from point 5 to B, no measurements are necessary other than the circumference of the circle from 5 to B, Fig. 5, which you have already placed upon the plate when your dividers were set.

The top of the breeching is round, as shown in Fig. 3, and at line B-B, Fig. 1, it is square, as will also be seen in Fig. 3. The top is laid out just the same as in any piece—square on one end and round on the other.

TO LAY OUT THE TOP.

First strike up the diagram, Fig. 3, and divide one quarter of the circle into any number of parts, as in this case 8 as shown, and numbered 1, 2, 3, 4, 5, 4, 3, 2 and 1. As the base of this is square, only one-eight of the circle is necessary, but to make it plain I have divided the quarter as shown. To get the triangles necessary to lay out the curve on the top of the breeching: First, get the perpendicular height in Fig. 1 from V to U, and mark this distance from A to X, Fig. 4; then lay down a base line any length at right angle with line A-X. Now, with tram points set from B to 1, Fig. 3, carry this measurement to Fig. 4 and with A as center, strike an arc at 1. Now take the distance from B to 2, Fig. 3, and with one point set at A, Fig. 4; strike another arc at 2; then take the distance from B to 3, Fig. 3, and from A, Fig. 4, mark off point 3. Then go back to Fig. 3 and get the distance from B to 4 and transfer to Fig. 4. Next get the length of line B to 5, Fig. 3, and mark off a corresponding distance from A to 5, Fig. 4. Now run these lines from 5, 4, 3, 2 and 1 to X, and the necessary triangles are complete. By these triangles the top of the breeching will be laid out. Now the question may arise, why is it necessary to strike up Fig. 4? The answer is that we get two measurements—first the perpendicular height, and second the measurements at the bottom line, showing how far away from the corner B the different points on the circle are. With this explanation we will proceed to lay out the top of the breeching.

Now set your tram points from A to 1, Fig. 4, and with B-B, Fig. 5, as centers, strike the arcs at 1, thus producing the center hole at top. Now, with dividers set for the spaces around the circle in Fig. 3, with 1 as center, Fig. 5, strike an arc each side of the center as at 2-2. Now go back to Fig. 4 and get the distance from A to 2, and with one end of tram points set at B and B, Fig. 5, strike an arc at 2 and 2 each side of the center, to cut the arcs just struck from point 1. Then with dividers set as before, and with 2 and 2 as centers, strike an arc at 3 and 3. Now go back to Fig 4 again and get the distance from A to 3 and from B-B, Fig. 5, strike the arcs to cut those just struck at 3 and 3. Now get the distance A-4 and A-5 from Fig. 4 and transfer to Fig. 5, using the dividers as set for the spaces and produce the points 4 and 5. Now draw the curve line through these points and the line for the rivet holes will be complete. Now lay down the line of rivet holes along the sides and locate the rivet holes. and Fig. 5 will be complete.

The upper end of Fig. 6 is laid out the same way, except the points B and B in Fig. 5 are placed at the outside corner on the sheet, while in Fig. 6 they are located on the corner of the flange line as shown. The lower part of Fig. 6 is simply a reproduction of that part of Fig. 1 below the line B-B, with the necessary lap added for rivets and flange. The seams are located on the quarter, as this is the most convenient place for same, as the work is gotten out with but very little waste.—*Motive Power.*

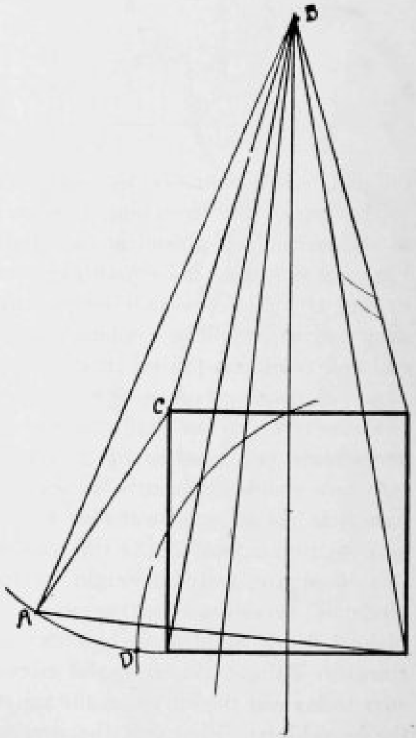
Editor DRAFTSMAN: Your article by Mr. Arthur B. Babbitt in the December number of THE DRAFTSMAN entitled "Something for Our Geometrical Friends," was a very interesting problem.

Referring to the accompanying sketch, I would answer his question, "Where is the trouble?" by saying that line AB does not in any case cross inside the corner of "C" of the square.

By using point "D" instead of "A", as Mr. Babbitt shows, point "B" would be infinitely high or at least high enough to still keep line "AB" outside of corner "C."

Proving this would blot out the problem entirely.

H. MACDONALD.



ARCHITECTURAL.

Architectural Lettering.

A DESCRIPTION OF VARIOUS LETTER FORMS SPECIALLY ADAPTED FOR THE PRACTICAL USE OF THE DRAFTSMAN ON PLANS, WORKING DRAWINGS.

PRACTICALLY all the lettering now used in architectural offices in this country is derived, however remotely it may seem in some cases, from the old Roman capitals as developed and defined during the period of the Italian Renaissance. These Renaissance forms should be studied first at a large size in order to appre-

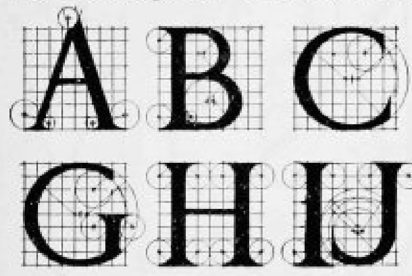


FIG. 1.)

ciate properly the beauty and the subtlety of their individual proportions. For this purpose it is well to draw out at rather a large scale—four or four and one-half inches in height —a set of these letters of some recognized standard form; and in order to insure an approximately correct result some such method of construction as that shown in Figs. 1 and 2 should be followed. This alphabet, a product of the Renaissance, though of German origin, is one adapted from the well known letters devised by Albrecht Dürer about 1525, and is here

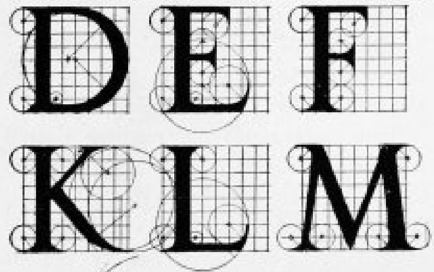


Fig. 1 (concluded.)

merely redrawn to a simpler constructive method and arranged in a more condensed fashion. This may be accepted as a good general form of Roman capital letter in outline, although it lacks a little of the Italian delicacy of feeling, and thus betrays its German origin.

The letter is here shown in a complete alphabet, including those letters

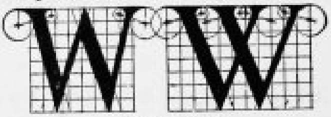


FIG. 2.)

usually omitted from the Classic or Italian inscriptions: the J, U (the V in its modern form), and two alternative W's, which are separately drawn out in Fig. 2. These three do not properly form part of the Classic alphabet and have come into use only within comparatively modern times. For this reason, in any strictly Classic inscription, the letter I should be used in place of the J, and the V in place of the U. It is sometimes necessary to use the W in our modern spelling, when the one composed of the double V should always be employed.

The system of construction shown in this alphabet is not exactly the one that Dürer himself devised. The main forms of the letters, as well as their proportions, are very closely copied from the original alphabet, but the construction has been somewhat simplified and some few minor changes made in the letters themselves, tending more towards a modern and more uniform character. The two W's, one showing the construction with the use of the two overlapping letters V, and one showing the W incorporated upon

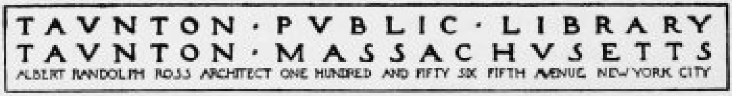


FIG. 3.)

the same square unit that carries the other letters (the latter form being the one used by Dürer himself), are shown separately in Fig. 2. It should be noticed that every letter in the alphabet, except one or two that of necessity lack the requisite width—such as the I and the J—is based upon and fills up the outlines of a square, or, in the case of the round letters, a circle

FIG. 4.

which is contained within the square. This alphabet should be compared with the alphabet in Fig. 4, attributed to Sebastian Serlio, an Italian architect of the sixteenth century. By means of this comparison a very good idea may be obtained of the differences and characteristics that distinguish the Italian and German traits in practically contemporaneous lettering.

After once drawing out these letters at a large size, the beginner may find that he has unconsciously acquired a better constructive feeling for the general proportions of the *individual* letters; and he should thereafter form the letters free-hand without the aid of any such scheme of construction, merely referring occasionally to the large chart as a sort of guide or check upon the eye. For this purpose it should be placed conveniently, so that it may be referred to when one is in doubt as to the outline of any individual letter. By allowing this course and practicing thoroughly the use of the letters in word combinations, a ready command over this important style of letter will eventually be acquired.

JERSEY · CITY · FREE · PVBLIC · LIBRARY
·SCALE · ONE · INCH · EQVALS · FOVR · FEET·
BRITE · AND · BACON · ARCHITECTS · III · FIFTH · AVENVE · NEW · YORK · CITY ·

Fig. 5.

In practice it will soon be discovered that a letter in outline and of small size is more difficult to draw than one solidly blacked-in, because the defining outline must be even upon both its edges; and that as the eye follows more the inner side of this line than it does the outer, the inaccuracies of the outer side of the line are likely to show up against the neighboring letters, and produce an irregularity of effect that it is difficult to overcome; while in a solidly blacked-in letters, it is the outline and proportions alone with which the draftsman must concern himself. Therefore, a letter in the same style is more easily and rapidly drawn when solidly blacked-in than as an "open" or outline letter.

In many cases where it is desired to give a more or less formal and still sketchy effect, a letter of the same construction but with certain differences in its characteristics may be used. It should not be so difficult to draw, and much of the same character may still be retained in a form that is much easier to execute. Some such letter as is shown at the top of Fig. 9, or any other personal variation of a similar form such as may be better adapted to the pen of the individual draftsman, would answer this purpose. The titles shown in Figs. 3 and 5 include letter of this same general type, but of essentially different character.

ABCE

Fig. 6.

· BILL OF INDIANA LIMESTONE

GENESEE VALLEY TRVST CO'S BVILDING

Fig 8. The Title from Architectural Drawing. Claude Fayette Bragdon, Architect.

In drawing a letter that is to be incised in stone, it is customary to show, in addition to the outline, a third line about in the center of the space between the outside lines. This additional line represents the internal angle that occurs at the meeting of the two sloping faces used to define the letter. An example is shown in Fig. 7, taken from drawings for a building by McKim, Mead & White, the same convention being frankly employed to emphasize the principal lettering of a pen-drawn title.

For the purpose of devising a letter that may be drawn with one stroke of the pen, and at the same time retain the general character of the larger, more Classic alphabet, in order that it may be consistently used for less important lettering on the same drawing, it is interesting to try the

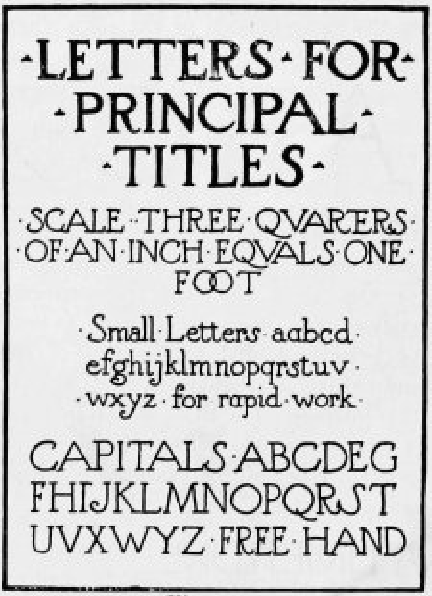


Fig. 9.

experiment of making a skeleton of the letters in Figs. 1 and 2. his consists in running a single heavy line around in the middle of the strokes that form the outline of these letters. This "skeleton" letter, with a few modifications, will be found to make the best possible capital letter for rapid use on working drawings, etc., and in a larger size it may be used to advantage for titling details. It will also prove to be singularly effective for principal lettering on plans, to give names of rooms, etc., while in a still smaller size it may sometimes be used for notes, although a minuscule or lower-case letter will be found more generally useful for this purpose.

In Fig. 6 are shown four letters where the skeleton has been drawn within the outline of the more Classic form. It is unnecessary to continue this experiment at greater length, as the idea is sufficiently developed in these four letters. In addition, it is merely the theoretical part of the experiment that it is desirable to impress upon the draftsman. In practice it will be found advisable to make certain further variations from this "skeleton" in order to obtain the most pleasing effect possible with a single-line letter. But the basic relationship of these two forms will amply indicate the propriety of using them in combination or upon the same drawing.

It will be found that the letter more fully shown in Fig. 9 is almost the same as the letter produced by this "skeleton" method, except that it is more condensed. That is, the letters are narrower for their height and a little freer or easier in treatment. This means that they can be drawn more rapidly and occupy less space, and also that they will produce a more felicitous effect.

In actual practice, the free capitals shown in Fig. 9 will be found to be of the shape that can be made most rapidly and easily, and this style or some similar letter should be studied

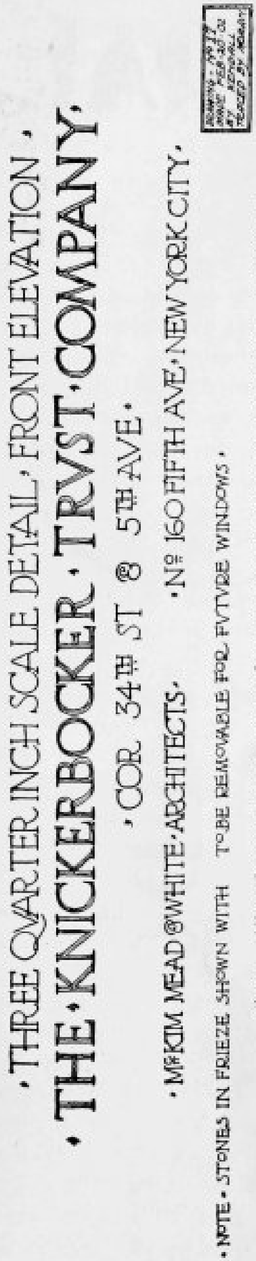


Fig. 7. Title from Drawing of Building for the Knickerbocker Trust Co., New York. McKim, Mead & White, Architects.

and practiced very carefully.

Other examples of similar one-line capitals will be found used with Classic outline or blacked-in capitals on drawings, Figs. 3, 5, and 7. In Fig. 8, this one-line letter is used for a principal title as well, and with good effect.

In Fig. 9 is shown a complete alphabet of this single-line letter, and also an excellent form of small letter that may be used with any of these capitals. It is quite as plain as any Engineer's letter, is easier to make, and, when correctly placed upon the drawing, is much more decorative. Fig. 9 represents the actual letter shapes that are used on architectural drawings. As they are so valuable to draftsmen, they should always be at hand for instant use.—"*The Technical World.*"

NEW COURT HOUSE.

The new court house of Cuyahoga County, in which Cleveland, O., is situated, it not to cost more than \$3,000,000 and the content not to be more than 6,000,000 cubic feet.

The supervising architects figured several times before they could cut the price to \$3,000,000, but now they promise to double their force of draftsmen and get the revised plans out so to get the work ready for the foundations next fall.

The cost of furnishing the building, paying the architects and other expenses will be about \$1,500,000, for the architects will get 5 per cent. of \$3,000,000, making \$150,000 as the amount of their fee.

STRUCTURAL.

Steel Columns.

THE subject of the interior columns for steel buildings forms one of the most important branches of modern building design, and greater variations are probably to be found here than in any other of the vital features of steel construction. The subject of fireproof construction is steadily growing in importance. The need of fireproof buildings in the business centers of our great cities has been only too well demonstrated to us by the recent fires at Baltimore and Rochester and the large number of smaller conflagrations which have taken place throughout the country during this last winter.

The substitution of steel for iron in the composition of columns may be cited as one of those radical changes which have taken place in the last few years and which show unmistakably the tendency of the times to depart from such forms of construction as involve any large degree of risk or uncertainty. The adoption of the steel column has brought with it a large number of forms of column construction, each having its own good points and special applications. The more prominent forms of steel columns, as used in American building practice, include channels connected by plates or lattice, plates and angles in various combinations and "Z" bar columns. Beside these types and the considerable number of variations found in each there are a number of patented forms which have been used less extensively. In Fig. 1 the commonest forms of channel columns are shown.

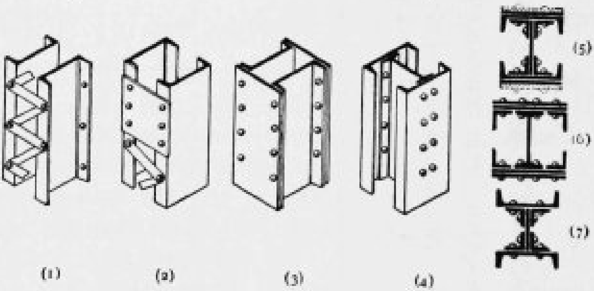


Fig. 1.

For light members, as in upper stories, the channels are often placed back to back or flange to flange, and connected by means of tie-plates and lattice bars. The former method of placing the channels back to back is somewhat easier as regards the riveting. The third form shown, with cover plates either single or double, is one of the most common column sections employed. The fourth form shows a combination of two channels and an I-beam. A variation of this section is sometimes made by substituting a plate and four angles in place of the I-beam, or one or more plates and two angles for the channel sections, as shown in designs 5, 6 and 7. Typical forms of plate and angle columns are shown in Fig. 2.

The simplest combination is that made in the form of a beam. One or more webs may be used, or fillers between the angles, as shown by the dotted lines, but any additional material is placed to better advantage if used in the form of cover-plates, riveted to the outer legs of the angles. The I section of plates and angles is extensively used in cases where the loads are sufficiently light to permit of it. The box form of plates and angles, shown as the second type in the illustration, is one of the most ordinary as well as commendable forms in common use. This section may be readily strengthened by using additional web-plates, cover-plates or filler-plates, as illustrated by the dotted lines, or by section 3. Columns of this form have been used in a great many notable high buildings; as for example, the St. Paul building in New York City, and the Masonic Temple in Chicago.

Z-bar columns and variations are shown in Fig. 3. The ordinary section is as in form 1, this being made in the standard sizes of 6-inch, 8-inch, 10-inch and 12-inch columns, by using 3-inch, 4-inch, 5-inch and 6-inch Z's respectively. When the load can be safely carried without the aid of cover-plates, and if the size of the column does not become too large for its relative position in the building, it is more economical to use the simple section, but when additional area is required, one or more cover-plates may be added as shown by the dotted lines. Form 2, known as the "standard dimensions" Z-bar column, was designed to allow of the outside dimensions of such columns being kept standard for all stories, irrespective of the size or thickness of Z's required, but on account of the tie-plates required in either one or both directions increasing the shop costs, and decreasing the efficiency of the column under eccentric loading, the form has never come into exten-

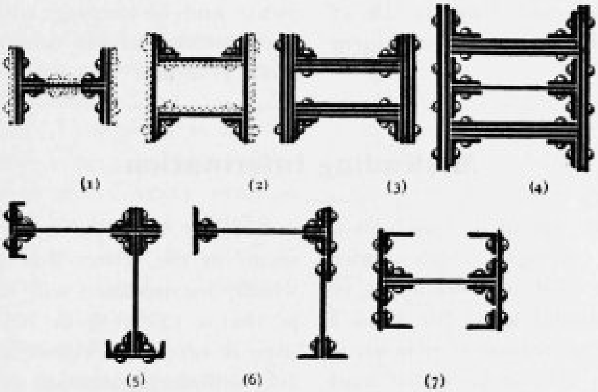
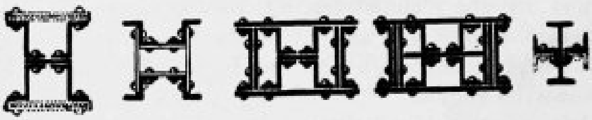


Fig. 2.

sive use. Sections 3 and 4 show heavy columns combining Z's with plates and channels. Section 5 shows a combination of two Z-bars with one I-beam.

examples of building construction. The relative advantages of these standard sections are obviously of importance in influencing a choice, but that any particular type can be selected as



(1) (2) (3) (4) (5)

Fig. 3.

The foregoing examples will serve to show the great number of forms offered the designer from which a selection may be made; nearly all of them are to be found in prominent the best for universal application is manifestly impossible; selection must be made to fit the particular requirements and in keeping with the ideas and opinions of the designer.—*Ryerson's Monthly.*

Misleading Information.

THE writer has in his possession several catalogs, which under the head of useful information give the safe distributed loads for steel I beams. In some instances, mention is made that the safe concentrated load is one-half that of the concentrated load, while in others, it is completely ignored; in none of them is mention made of that limiting value of medium and long beams, namely the lateral deflection.

The result is that occasionally some one not versed in I beam lore uses this information in its literal sense, and is much surprised later to see the beam fail under a much less load than the tabulated one. It does not seem to be generally known outside of those directly engaged in structural designing that I beams which are not supported laterally usually fail laterally unless the beam is quite short. It seems to the writer that publications which, for instance will tell the public that a 12" 31½ lb. beam with 30' span is safe for a center load of 6400 lbs., without mentioning that the beam should be sufficiently braced laterally, is spreading misleading information which might easily cost human life and financial loss.

I know of one instance in which failure occurred in a beam selected from catalog information and several more in which it was mere good fortune that it did not occur, the beams having a factor of safety of about two.

It is to be generally regretted that this condition exists, as there are a class of men who use this free information literally and whose faith in it is unbounded because it is in print.

HOME STUDY.

The Helix.

IF a point moves in two directions about a line as an axis, that is, around and in the same direction as the line, at the same time, a *helical* curve results.

A simple form of this curve is found in a common spring and the lines which bound the threads of screws.

The line of a winding stairway is a helix and is not a *spiral* stairway as is so commonly called.

The motion of the point in its different directions may be uniform or variable but in the common forms of the curve both motions are uniform and are produced by a point which moves uniformly around and along a cylinder at the same time.

The distance which the point travels along the cylinder, in going once around it, is called the *pitch*, which is the same amount that the nut on a bolt moves when the latter is turned through one revolution.

To draw a common helix, divide the circle which is the top view of the cylinder into any even number of equal parts and divide the pitch into the same number of equal parts as in Fig. 1.

When the point has moved upon the circle of the top view over one of the equal parts, it has moved in the front view along the axis a distance equal to one of the equal parts of the pitch A to 1. When it has moved one quarter around the circle, it has moved one quarter of the pitch and so on for the whole revolution of the

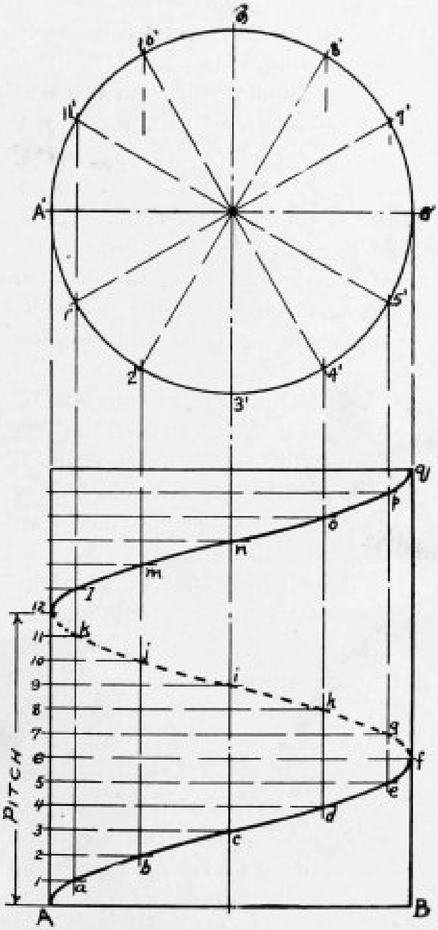


Fig. 1.

Hence to obtain all the points for
generating point.
the front view of the helix, draw par-

allels to the axis from the points of division in the circle and intersect these lines by perpendiculars to the axis from the equal division of the pitch.

In Fig. 1, the pitch is divided into 12 equal parts. Lines 1, 2, 3, 4, etc. are drawn horizontally and lines 1'a, 2'b, 3'c, etc. are drawn vertically and these vertical lines answer for finding points g, h, i, j, and on the far side of the cylinder and points l, m, n, o, etc. on the front.

A line should then be drawn through these points with the aid of the French curve.

In Fig. 2 is shown a helical flange, passing around a cylinder, the edge of flange is generated as in Fig. 1 and the inner edge by using the division on the small circle but the equal divisions of the pitch the same for the outer edge.

A *screw* is a helical projection or thread formed upon cylinder and is a very common device in mechanical construction, the uses to which it is placed being to produce pressure, contact and in transmitting motion.

The threads of screws are generally made to fit a block, with internal threads, called a *nut* (not a *tap*) and and article with a head on one end with threads on the other, engaging a nut is called a *bolt*.

Screws are made either right or left handed, of which the former are more common and are distinguished by their nuts advancing along the screw when the latter is turned in the direction in which the hands of a watch move.

On a drawing, the right handed screws are determined by the fact that the threads incline to the left when as in left portion of *A*, Fig. 3, or to the right if the screw was placed vertical. The right portion of *A*, Fig. 3 represents a *left hand* screw.

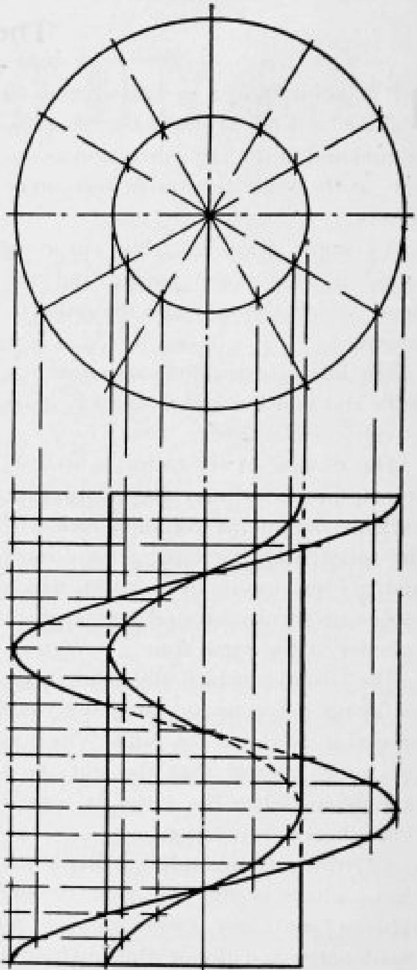


Fig. 2.

The more common form is the V thread, although there are a few modifications of it that are in general use.

The *pitch* of a screw is the same as in the case of the helix, and instead of giving the amount of pitch in describing a screw, it is customary to give the number of threads per inch of screw.

For example, a screw is 1½ inches in diameter has 6 threads to the inch, that is, the screw has a thread wound

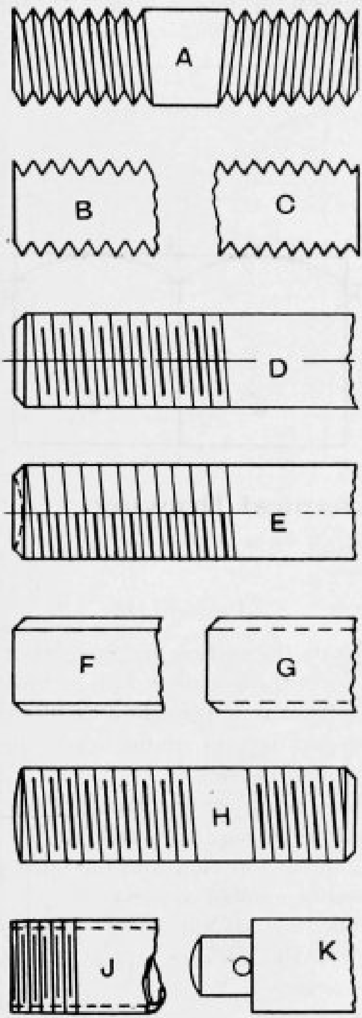


Fig. 3.

around it 6 times in every inch of its length.

The work of drawing in the V part of the thread is often quite tedious so that a convenient method must be used to illustrate a screw and in Fig. 3 are the common forms.

The form *A* has already been mentioned and should only be used on very exact or on large drawings. *B* and *C* might be used but look unfinished. *D* and *E* are the most common but *F* and *G* should never be used.

In style *H* is shown a rod with threads at both ends, commonly called a *stud*, one end chamfered and with the other round. The latter end is formed by an arc of a radius of *2d* where *d* is the diameter of the body of the screw, the chamfered end being made with lines at an angle of 45°.

The thread lines may be made as shown at E if desired and this may also be applied to the form at J which is to represent the threaded end of a pipe. The thread of pipes are cut on a taper which is ¾" to 1'. The interior surface of the pipe should be shown by dotted lines.

When the nut is to be secured by a pin, the threads are sometimes cut off, leaving a reduced portion as at K.

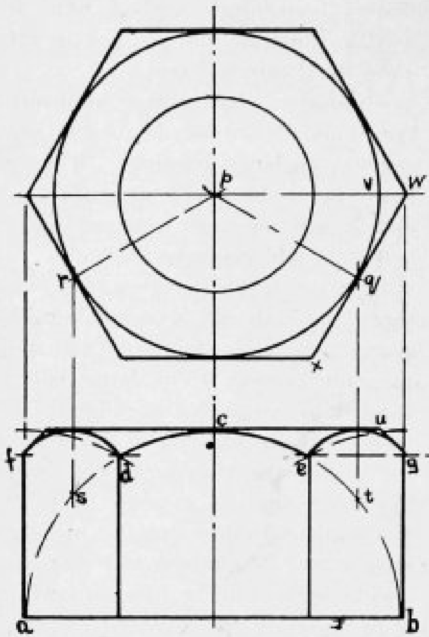
There are several shapes of V-threads, the one with sharp points, Fig. 4, with lines at an angle of 60° being the more common.

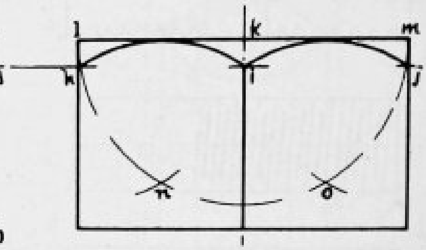
To Draw a Hexigon Nut.

Many methods have been suggested whereby the draftsman may draw the form of a hexagon nut and the following is one of them:

On the centerline CP, with radius yc equal to the diameter of the bolt, draw arc ad ceb and with the same radius and *a* and *b* as centers, cut arcs at d and e. The small arcs fd and eg are drawn with centers at s and t. In the side view, with k as a center and a radius pz, draw arc lnom and with l and m as centers, cut arcs at no and o, which are the centers for the arcs hi and ij.

The straight lines in the top view are made by means of the tee-square and 30° triangle.





Elementary Course in Mechanical Drawing

(Continued from April Issue.)

PLATE XVIII.

Problem I.

Draw a helical curve on a cylinder 2½" in diameter with a pitch of 2". The center of the circle is to be 2½" from the left border line and 1¾" from the top border and the front elevation to be ¼" from the circle and 3" long. Lay out the curve as explained for Fig. 1.

Problem II.

Draw a helical flange as shown in Fig 2 with the length of cylinder and large circle the same as in Fig. 1.

The diameter of the inner circle to be one-half the large one.

Let the base of the circle be ½" from the bottom border line and place the top view near the front view.

Problem III.

Draw the section and half top view of a nut for a 3" bolt with V threads. The front view is to show an elevation and part section of the screw and a section of the nut.

The points in the thread lines are found as in Fig. 2, by dividing the circles in the top view and the pitch into the same number of parts.

The nut should be 5" long, 2½" wide in the top view and 2½" thick in the front.

Locate the center line of Fig. 3 7¼" from the left border line and the top view is to be 1¼" from the top border and the top of the nut in the front view to be 5¾" from the top bor line also.

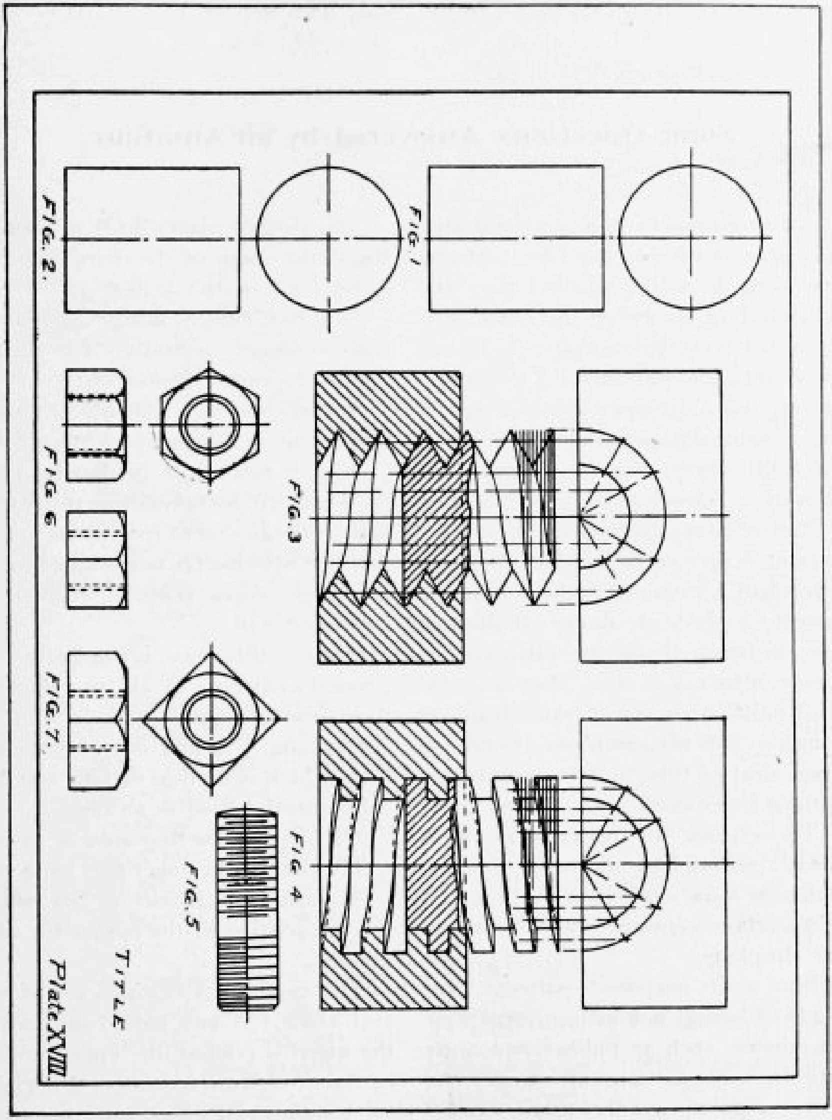
Draw the section and half view of a nut for a 3" bolt with square threads.

Locate the center line of Fig. 4, 3¾" from the right border line and the views are to be arranged on a line with those in Fig. 3.

Problem V.

Draw a 1" stud 3½" long and represent the threads by two convenient methods.

Locate its center line 3½" above the bottom border line and let its right end be on a line with Fig. 4 as shown.



Problem VI.

Draw three views of a hexagon nut for a 1" bolt by means of one of the methods described above.

The center of top view to be 3" above the bottom border and 3" from the center of Fig. 2. Center of side view to be $1\frac{1}{2}$" from the center of the front view.

Problem VII.

Draw two views of a square nut for a 1" bolt by means of one of the methods given above.

The center lines of the top view on a line with that of Fig. 6 and 6" from the right border line.

Some Questions Answered by an Amateur.

A pattern-maker must first consider the amount of use that the patterns are likely to serve, whether they are for standard or special machines, and the quality of the castings, so far as affected by the patterns. A first-class pattern may cost twice as much as another, yet a cheap one will do almost as well where there are but few moulds to form.

Patterns may be parted so as to be "rammed up" on fallow boards or a level floor, or they may be solid, and have to be bedded; pieces on the top may be made loose, or fastened so they can be taken off. They may be well finished so as to draw clean, or rough so that the mould may require a great deal of time to dress up after a pattern is removed.

The expense of patterns is often greatly reduced by the use of cores, but is in some cases increased.

A certain allowance must be made for shrinkage.

For most purposes, patterns are made of wood, but in heavy parts of machinery, such as pulleys and gear wheels, iron patterns are best. As there must always be more or less loose sand in a casting, it is important to arrange the pattern so that this part will come in the least disadvantageous position.

The pattern-maker uses a drawing to get the shape of the object, and the dimensions of the same.

A shrink-rule is a rule used by a pattern-maker, providing for shrinkage of the metal while cooling.

A core box is a divisible box in which clay is rammed to form cores.

A core print is a projecting piece on a pattern for moulding to form a hole in the mould to receive the end of the core by which it is sustained in the mould in proper position, relative to the object cast.

Draft in this sense is the slight tape given to patterns to aid in removing them from the sand.

Dry sand is a mixture of sand and loam which is used in making moulds, subsequently dried in an oven.

The cope is the top side of mould.

The drag is the lower part of mould.

A flash is a frame or box which holds a portion of the mould for casting.

The moulds for castings are of several kinds. A pen mould into which the metal is poured, the upper surface of the fluid metal assuming a horizontal position, such as ingots. Close moulds of sand are those in which articles of iron, brass, bronze, etc., are made.

CURRENT TOPICS.

A slight difference in colors on the cover was made in the March issue of THE DRAFTSMAN, but it made a better appearance.

A certain draftsman has a notice in the "Want Column" of "Miscellaneous Data on Brickwork." It is miscellaneous but it is worth many times the price asked and no draftsman should be without this kind of information, so he may be prepared to figure this class of work.

THE DRAFTSMAN has subscribers in Alaska, China, Australia, New Zealand, Hawaii Islands, Mexico, Chili, Cuba, Spain, England, Canada, and recent inquiries have been had from India.

A certain magazine announces that with its increased equipment for producing a better periodical, it will no doubt raise the subscription price, but if $2.00 be sent at once, the name would be entered for the length of the life of the subscriber. This means 20 years at the present price and the magazine is worth the price.

Another magazine offers to keep the name on their list for five years for the sum of $3.00. If any one will send $3.00, we will send THE DRAFTSMAN for five years. We will endeavor to be liberal, too. THE DRAFTSMAN is gaining strength each month.

The Metric System.

In *The American Machinist* is seen two items following each other.

1st. "The House of Lords has passed unanimously the bill making the use of the metric system compulsory in Great Britain after April 5, 1906."

2nd. "At a hearing of the House Committee on Coinage, Weights and Measures, held March 10, Mr. L. D. Burlingame, chief draftsman of the Brown & Sharpe Manufacturing Co., presented in the name of the company, a protest against the passage of the pending bill."

So we are to stand still for a while or rather to go along in the same old rut with the same old weights and measures that are a blot on the name of civilization and advancement. It is to be hoped that the bill will be passed and the people given a certain time to prepare themselves for the new system.

Among the names recently added to our subscription list is one from Chili, South America.

A Notice, but a Good One.

The following notice appeared recently in a well known drafting room:

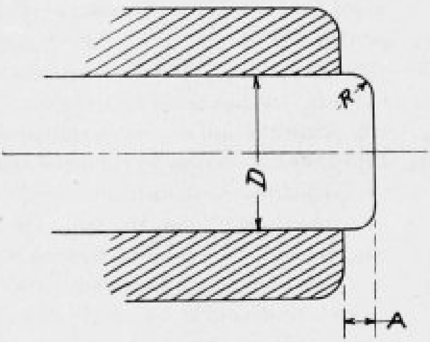
"Gentlemen: Of late there has been a general laxity about observing the rules of this office. Some rules in business should be understood and must be here. General conversation during business hours is prohibited, as is whistling, humming, drumming on the desk or any other unnecessary and distracting noise.. You must stay at your boards, except when necessary to interview each other about the work in hand, then talking must be in a low voice. The hour for beginning work is 7:30 a. m. sharp. I find a number of you do take advantage of my absence from the room to indulge in a general conversation and rough house. I will not tolerate this and the first one who shows a disposition to continue under the old regime may expect to *be fired.* You are here to work, that is all. Respectfully,

"________."

Corners for Projecting Shafts.

ENCLOSED you will find a sketch and table, giving good proportions for corners of projecting shafts,

Possibly this may be or some service to you in filling up some empty corner of THE DRAFTSMAN.



D	A	R
1/4 ~ 7/16	1/32	.03
1/2 ~ 9/16	1/16	.04
5/8 – 11/16	1/16	.05
3/4 ~ 13/16	1/16	.06
7/8 ~ 15/16	3/32	.07
1 – 1 3/16	3/32	.08
1 1/4 – 1 7/16	3/32	3/32
1 1/2 – 1 15/16	1/8	1/8
2 ~ 2 7/16	3/16	5/32
2 1/2 ——	3/16	3/16

THE DRAFTSMAN, in its new cover and enlarged size, is surely a decided improvement, and this is simply a reflection of what is found within. It should appeal to all men who call themselves draftsmen.

Sincerely yours,
ARTHUR B. BABBITT.

Some Valuable Hints for the Drafting Office.

BY HENRY C. HAMMACK.

MANY schemes have been introduced and used for designating tracings, but we find that the one universally adopted is that whereby each tracing is given a number. Mostly the numbers are taken in consecutive order from one up, and if a new tracing is made, no matter what part the tracing may be made to show, whether a cylinder or boiler, no exceptions will be taken, but the new tracing will be given the next number in the series which has not yet been used. While there is no question but what the method of giving each tracing a number, and each new tracing the next number in the consecutive series, is far better than the old method of keeping track of your tracings by using the names of the different parts to designate same, yet we will ask the question, "What method have you of grouping the numbers of any particular subject so that they will really become self-indexed? The answer to this question would undoubtedly be "Not any." Then if not, why not! This is a point that will be found that has not been looked after in many of our drafting offices, and if a method is employed it is usually undertaken, as stated before, by using subjects and with this is connected a great amount of detail and unnecessary work. Of course, it is not the claim of the writer that the method described herein will be perfect by any means or that it cannot be improved upon, but it is claimed that the same will remedy this fault above mentioned and will materially aid in looking up tracings, either for reference or for the purpose of having new blue prints made from same for use in reference drawers, and will also tend to produce a self index.

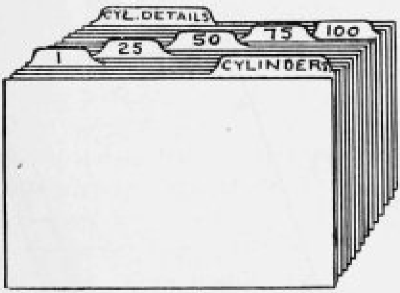


FIG. 1.

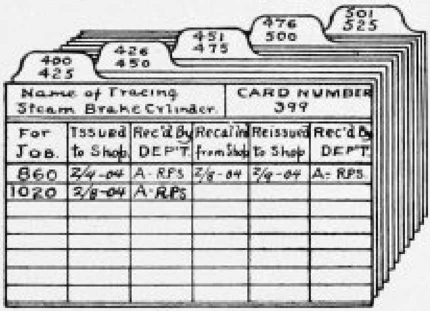


FIG. 5.

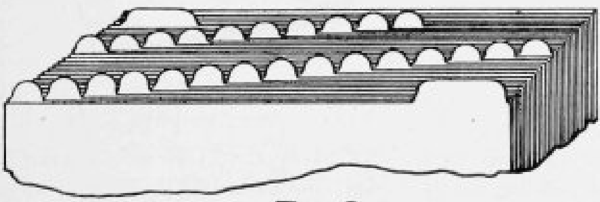


FIG. 2.

In all modern drafting offices blue prints are used for reference instead of the original tracings, in order to save the wear and tear an the tracings as much as possible, hence what I mean by prints for reference drawers, are the prints used for this purpose.

Now, while I do not object to numbering tracings in consecutive order, yet the method of arranging an index will be found a much easier task if some exceptions are taken in using the numbers. We will bring the card index into use, and will say that you use or reserve a certain series of numbers for certain subjects. For instance, say that you are manufacturing engines, boilers, etc. For cylinders and cylinder details, which will be classified under main head of cylinders, you would use numbers ranging from 1 up to 500. This depending on how many tracings of cylinders and details you would have to take care of. Then you could use for boiler tracings and numbers used in the first series which in the case of cylinders and cylinder details are numbers 1 to 500, the second series would be numbered like this: 1-2, 2-2, 3-2, etc., the figures representing the main numbers being twice the size of the figures designating the series. In this way the main numbers first allotted for cylinders and cylinder details would always remain the same, still there would be ample provision for increase, even if the figures used to designate the series would only run as high as 10, as it is

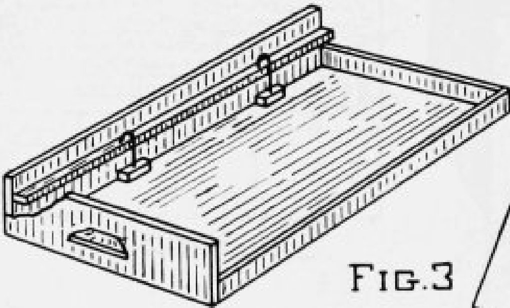


FIG. 3

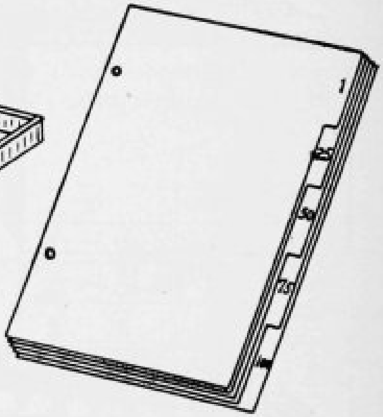


FIG. 4

boiler details numbers ranging from 500 to 1000, this also depending on the number you would have to take care of. Then, so on, running numbers up as high as would be required to meet your demands. Then in time, suppose you would use all the numbers allotted for any particular subject, to simplify matters and to refrain from using other new numbers, that is to say, suppose that numbers from 5000 up which would be available in allotting numbers to any new subject had not been used instead of using these numbers we would retain the main not likely that you would have more than one thousand tracings of any one particular subject. If it was desired the letters of the alphabet could be used to designate the series, instead of numbers.

Now, in arranging our card index we have two important points to look after, namely: Card numbers and names of tracings. The file suitable in which to place index cards showing tracing numbers or card numbers as they are above termed and other general information which you would desire to have on card, is shown in Fig.

1. The guide cards showing numbers being one-fifth cut and the guide cards showing names of tracings or parts of machinery being one-third cut. The guide cards showing numbers to be placed in index case with the tab at left hand side, running left to right and the guide card showing name of tracing at right hand side running right to left, or vice versa. In this way the guides showing numbers will not be confusing with guides showing names of tracings. Now, in going further into this, supposing numbers 1 to 100 in your series of 1 to 500 would be sufficient to carry tracings showing general plan of cylinders, then you would have available numbers from 100 to 500, or 400 numbers which could be used for cylinder details of the different cylinders. Then on the main guides in index you could show something like this: "CYLINDER DETAILS," then you could subdivide the different details under cylinders so they could be easily turned to without running over all cards under details if you were looking for any particular part. What I mean by sub-divide is to have Guide Cards showing each detail separate. As an example, have Guide Cards showing Valve Stems, Valve Stem Stuffing Box, Piston Rod, Links, Link Blocks, etc. Then, for instance, all cards for links of all size cylinders will be found following the Sub-Guide Card "Links." In doing this it will also be necessary to sub-divide your numbers. To explain this, will say that the first Sub-Guide Card under CYLINDER DETAILS would be Cylinder Heads; then you would allot so many numbers to cylinder heads just as the requirements would demand. In all cases you should group your numbers, say, in sets of ten, twenty-five, fifty, seventy-five or one hundred. That is, in the case of cylinder heads, the first number in your series would be 101, and if cylinder heads would require 100 numbers, your Guide Cards would show like this: 101, 125, 150, 175, 201. If the case would happen to be that you would only require twenty numbers, then Guide Cards would show like this: 101, 110, 121. We arrange it in this way for the reason that if you should be looking for a cylinder head knowing the number to be 105 you would know at a glance at your Guide Cards that this number would be found in index cards between 101 and 110.

As it would be advisable to classify or arrange your cards in your Index Case so you could pick out a card for a certain size cylinder or certain detail part for any certain size cylinder without looking over all the cards under cylinders, I would suggest that the index cards used to carry the card numbers or tracing numbers (as they could be called) of the cylinder and other information, have a little tab on it. See Fig. 2. Then we could use as a cross index to designate the different size cylinders, the stroke in inches, and supposing cylinders are of the following sizes: 8 x 8, 8 x 10, 8 x 12, etc. On this small tab on card you would place 8, 10 or 12 just as the case may be. Then, say you wanted to find card for an 8 x 10 cylinder, you would run down over the tabs in your index and find a tab which would have 10 on it, pick it out and you would have the card before you giving information relative to 8 x 10 cylinder together with tracing or card number, without regard to card number. Supposing that you had several size cylinders, the stroke being 10 inches, that is to say, you would have cylinders 5 x 10, 6 x 10, 8 x 10, 10 x 10, etc. In this event you would put on the small tab both the diameter of the cylinder and the stroke. As an example, will say that you have a 6 x 10 cylinder, you would put on the small tab 6-10, therefore showing at a glance the card in your index which has the tracing number and other information that you may desire in regard to this size cylinder. This same cross index can be used in designating cards showing tracing numbers for different cylinder detail parts.

If you were building boilers and would designate the size of same by horsepower and you had boiler tracings of 10, 20 ,30, 40 and 50 H. P. boilers, the general plan tracings could be given the first numbers in your series, same as in the above described case of cylinders and boiler details could be given the numbers following. Then the cards giving tracings numbers of the various H. H. boiler general plan tracings could show on the small tabs, as a means of cross index, the H. P. of the boilers, which could be 10, 20, 30, 40 and 50, and under details the same scheme could be used.

It appears to me that no matter what you are manufacturing, there is hardly any question but what you could use a system along the same line as above outlined, unless it would be in the foundry business, or a business where you were building machines, all of which are exactly duplicate of each other.

Now, in connection with the method of indexing your tracings and blue prints used as reference, I have a scheme for placing tracings or blue prints in the drawers in your case. There has been a great many methods employed; some use tubes and roll the tracings, others use envelopes, and some lay the tracings in the drawers loose, but I think I have a method which is equal to all. If you roll tracings that makes them hard to handle, and if you put them in envelopes there is always considerable time consumed and then the tracing will almost always turn up at the corners or double when putting same back in the envelope. If you lay them in loose and have, say, a hundred blue prints or tracings in one drawer, they are almost certain to get mixed up, and when you go to look for a certain print or tracing it will be found necessary to look over the entire number of prints or tracings in the drawer before you find the one you are looking for. My method is simply to use a file inside of the drawer, made along the same order as a letter file. I show my idea in Figs. 3 and 4. From this you can get a very good understanding of how it is arranged. Of course it is better to make the drawer or tray, as it may be called, same as shown in cut Fig. 3, that is, make the right side of the drawer and the rear end only about 1½" high, but if your case was made you could use the file in ordinary drawer or tray. The little curved rods can be made of ¼" spring steel wire, and then simply bore a hole in the block at the bottom of the drawer to receive the lower end of the rod and another hole in the strip running across the drawer near the top, to receive the other end. Have the holes bored a little snug and have the rods tapered at each end so they will fit in tight, but not so tight but what they can be removed when desired. Cardboard or binder-board divisions can be made of rather light weight card or binder board with two holes punched in same to receive the rods which holds same in place. Then the idea is, that if you have 100 tracings in one drawer, there would be four divisions and 25 tracings in each division. See Fig. 4. In this way, suppose you wanted Tracing Card No. 87, you would know that it would be in division 75 to 100. You could turn to this division and pick it out in almost a second, and then, after you had used the tracing it would only be a simple matter to replace it in the drawer in the proper division and its proper place in the division. It would also be more apt to be replaced in its proper place by using this method than if other methods are employed.

Another suggestion I have to offer is a method of keeping track of what cards you have in the shop. Of course, in a small shop this could probably be kept in a small memorandum book, but when you have from 500 to 1,000 cards in the shop at a time it becomes burdensome to keep track of same in this manner. The Card Index again comes into play. Of course, it is supposed that the tracings are all numbered as above outlined, and all prints issued in the shop are mounted on heavy binder board, and generally speaking are only known by card numbers. Then the style index card which I would suggest using is shown in Fig. 5. Now these cards are filed in a card index file case containing Numerical Guide Cards, same as shown in Fig. 5, the numbers on the guides running as high as the numbers of tracings you may have. Then, when a card is issued to the shop, one of these index cards is filled out and sent with the card to the department asking for it, and the card is receipted for either by the foreman or his clerk. Then the index card is sent back to the drafting room to be filed in the file case. When the shop is through with the card it is either sent back or recalled by the drafting room and filed away in racks made for that purpose to be held in readiness for another job which would take the same card. In some plants it may be that some of the cards would stay out in the shop until they are worn out before they are recalled. One of the advantages of having this record is that when you do a class of work where duplicate orders are frequent, the same cards being used for several different jobs, the drafting department can tell at a glance at this record whether certain cards are in the shop, and if so it is only a matter of recalling the cards and entering the new order number on same. There is also oftentimes requests made by the foremen of the different departments to the drafting department for cards for certain parts, stating they had never been received by them. Now, without this Index to rely upon, the drafting department would have no definite proof that the particular print asked for had been issued to the shop, and they would simply have to get out another print, have it mounted on a card and send it out. While this would not make so much difference in case the original card had not been changed to meet a request of the purchaser, yet if it should happen that the original card had been changed, which change would not be regular and would not show on the original tracing, you could quickly see the trouble it would cause. It sometimes happens that changes are desired to be made, and when foreman is requested to return the original card in order to make this change he will say that it cannot be located and that new card would have to be issued. Therefore, the drafting department would go ahead and get out new card and send it out in the shop, and in the meantime the foreman would locate the old card or original card and in some way get the cards mixed and go ahead and build the machine according to the original card. When the machine is sent out the customer would come back and say that it was not satisfactory by reason of certain changes not having been made as requested. You would endeavor to trace the trouble, and the foreman would produce the original card and state that he built the machine according to prints he had to work by. You would then take the matter up with the drafting department and would find that change was requested to have been made, but apparently they had not made the change on the card. Now, according to the circumstances the change was made and proper card issued to the shop, but the foreman used the wrong card. However, from the fact that no record was kept of the transaction, the drafting department would be held responsible for the error, while the fault was with the foreman. If this system is used nothing of this nature would occur, as on your index card record would be made of the new card having been issued to the shop, and if a mistake of this kind would occur it could be traced to the proper department. With such a system it will be found that it will not only aid the drafting department to keep their record clear on such points, but it will tend to make the foremen more careful of the cards issued to them and entrusted in their care.

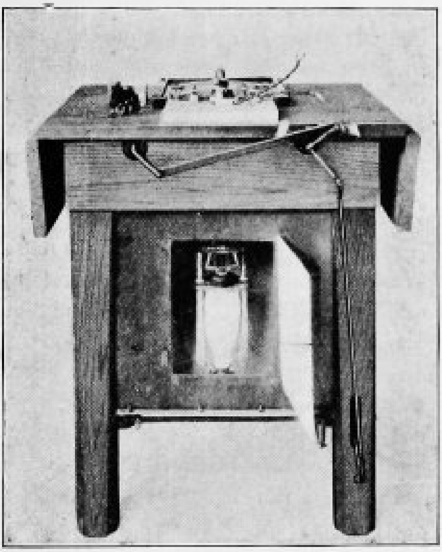
An Electro-Photographic Printing Press.

BY FRANK C. PERKINS.

While much has been done in recent years in the improvement of printing apparatus for ordinary type work, and electric motors are extensively employed to great advantage, little or nothing has been accomplished in the way of rapid machine photographic printing from negatives until recently. Mr. Fred P. Stevens, recently of Colorado Springs, well known from his famous "Sunrise" and "Sunset" pictures of Pike's Peak, has invented an automatic electric printing machine which will turn out a thousand prints per hour. The accompanying illustrations show the arrangement of the arc lamps and the printing frames as well as an exposition print from this electric press.

The operation to an observer is

identical to that of a foot-power printing press, the paper being fed in a sheet at a time by the right hand and removed by the left. The principal difference is that the pressure back that forces the paper into contact with the negative is brought down by the hand immediately after placing a sheet of paper in the frame, instead of automatically as in a printing press. But as it opens automatically when the exposure is shut off and as the speed of printing is about the same, the likeness is striking.



The machine facilitates job work and variation in the size of the negatives, their printing quality and the number of prints required makes no differences in the ease with which the machine is operated. For large manufacturing plants the photograph is being more and more extensively used in illustrating apparatus. Electrical machines, machine tools, turbines, engines, and in fact every form of manufactured article is now photographed in the shop, and when installed for filing and for illustrated article, magazine and catalog work. The wholesale printing from negatives in the old way is tedious and expensive. The electric printing machine will fill a long felt want.

One actual performance of the first machine built was the turning out of 1,250 4 x 5 prints from 75 negatives by a young lady operator in two hours and 45 minutes. Only one person was developing these prints or the output would have been doubled. A gross of amateur work can easily be printed from different negatives in 20 minutes. It is stated that the electro-photographic machine at St. Louis Exposition has printed with ease a gross of 8 x 10 prints in 19 minutes, losing only four prints from incorrect exposure.

Where several hundred prints are required from a negative the average speed of production is from 7 to 12 minutes to the gross, in regular practice, according to the size of the prints and the density of the negatives. After a little experience an operator does uniform work on negatives that require not over a quarter to a half second exposure. Ninety-five per cent. of the negatives in commercial work are exposed by the machine in less than a second. The exposure is controlled by the operator's foot working a treadle which is swung forward naturally from the knee, opening shutters of orange fabric which return to their normal position by the action of a spring when the pressure of the foot is released.

The electric light is a 500-candle

power enclosed arc in a reflecting box lined with asbestos and painted white. The printing press counter gives a record of the exact number of impressions.

Instrument for the Construction of Equivalent Geometrical Figures.

JEREMY C. WILLMON.

LOS ANGELES, California, has invented new and useful improvements in instruments for the construction of equivalent geometric figures. This invention relates to an instrument by means of which a square may be constructed whose area shall equal that of any given circle; also, by means of which a circle may be constructed the area of which shall equal any given square; also, by means of which a straight line may be drawn equal to the circumference of any given circle; also, by means of which a circle may be drawn whose circumference shall equal any given straight line; and the object thereof is to provide an instrument which will accomplish the above purposes without arithmetical calculation. He accomplishes this object by means of the instrument described herein and illustrated in the accompanying drawings, in which—

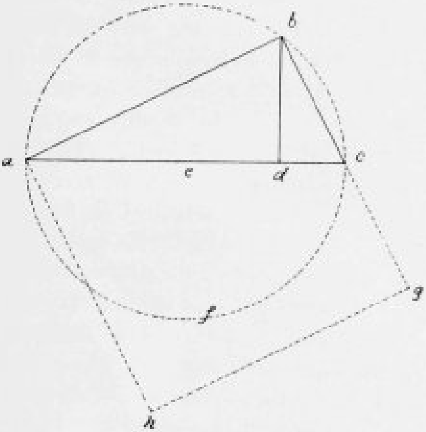
Figure 1 is a diagrammatic view of the formation of the essential angle of my instrument, with a circle and square shown in dotted lines. Fig. 2 is a side elevation showing a triangle embodying my invention.

In the drawings, A represents my complete triangle embodying my said invention and is formed in the following manner: Construct any circle—say the circle *a b c f*, having its center at *e*—then draw the line *a c*, forming the diameter of the circle. With *a* as a starting-point measure off on the diameter a distance equal to one-fourth part of the circumference which will terminate at the point marked *d*. At the point *d* erect a perpendicular to the line *a c*. This This perpendicular line will intersect the circumference of the circle at *b*. Then draw the lines *a b* and *b c*, thereby forming the right-angle triangle *a b c*, which forms a triangle embodying my invention in which the line *a b* forms the greater cathetus and the line *b c* forms the lesser cathetus and by means of which a square may be constructed equal in area to any given circle, or a circle may be constructed equal to any given square, or a straight line may be drawn equal to the circumference of any given circle, or a circle may be drawn the circumference of which shall equal the length of any given line.

To construct a square whose area shall equal that of any given circle, take any given circle and draw the diameter *a c*. Place my triangle with the apex angle *b a c* at *a* and with one side resting on the diameter *a c*. Mark on the circumference the point at which the side opposite that resting on the diameter and which helps to form the apex angle or the prolongation of such line intersects the circumference, and from this point draw a line to *a*, and this line will form one side of the required square.

To construct a circle whose area shall equal that of any given square, take any square, say *a b g h*, place the apex angle of my triangle at any corner of the square, with one of the sides which form said angle on the side of the square and the other side

Fig. 1.



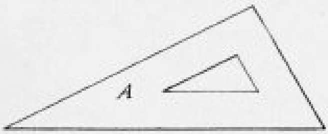


Fig. 2.

of the apex angle within or partly within the square, mark on the side of the square the point at which this last side or the prolongation thereof intersects the side of the square, and from this point draw a line to *a*, which forms the line *a c* and is the diameter of the required circle.

To draw a straight line equal to the circumference of a circle, take the triangle and place it upon the diameter of the circle with the point *a* resting on one end of the diameter and the base of hypotenuse *a c* resting upon the diameter, then prolong the line *a b* until it intersects the circumference of the circle. From this point draw a line to intersect the diameter and perpendicular thereto. The distance from the point at which this line intersects the diameter to the point *a* will be one-fourth the circumference of the circle and the same can be produced to the required distance.

To construct a circle whose circumference shall equal any given straight line, you will divide the line into four equal parts and lay the triangle upon the line with the hypotenuse resting thereon, with the point *a* at one of the ends thereof. Draw a perpendicular line from the point which is one-fourth of the distance from this end of this straight line. Draw a line along the greater cathetus to an intersection with this perpendicular line. This last line is bisected by a line at right angles thereto and the bisecting line extended to an intersection with the straight line. The point of intersection gives the center of the desired circle.

Proportional Dividers,

THIS invention relates to improvements in proportional dividers.

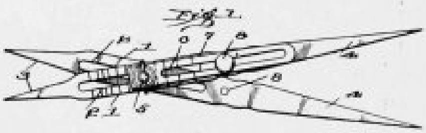
One object of this invention is to provide means by which the pivot-pin upon which the arms of the dividers swing may be securely held in its adjusted position, so that when the dividers have been once adjusted to any particular proportion there will be no danger of this adjustment being disturbed.

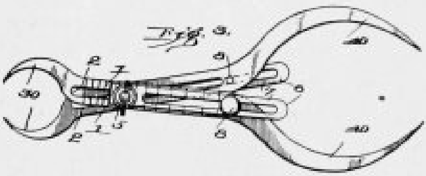
In the drawings, Figure 1 is a plan

view of an ordinary proportional divider having my invention applied thereto. Fig. 2 is a side view of the same. Fig. 3 is a plan view of proportional calipers.

Corresponding parts in all the figures are denoted by the same reference characters.

In using proportional dividers of the ordinary style it is usually necessary to take a large series of measurements with the dividers adjusted to





the same proportion. In doing this it often happens that the position of the pivot-pin within the slot becomes shifted, thus destroying the former proportion between the different ends of the divider and sometimes causing serious trouble in carrying out the work then in hand. By the use of my improvement in proportional dividers the probability of such disturbance of the adjustment is very slight.

Referring to Fig. 1, in which a proportional divider having my invention attached thereto is shown in opened position, 1 1 represent two arms which in accordance with the usual construction are provided with the central slots 2 2. 3 3 represent the short arms or ends of the divider, and 4 4 the long ends or arms. Passing through the slot in each arm is a pivot-pin 5, which is provided with a suitable nut. Outside of each arm is a holding arm or bar 6, which is provided with an opening adapted to snugly receive the pivot-pin and a longitudinal slot 7. Passing through the slot 7 and screwing into the body of the arm 4 is a clamp-screw 8, which is provided with a head of such character that it may be readily engaged and turned by the hand. Two of these holding arms or bars are provided—one upon each arm of the divider. By this means the pivot-pin 5 is securely held in its adjusted position in each arm and the liability for displacement is very much lessened. At the same time the pivot-pin 5 may act as a clamp-pin, which further insures against displacement.

The calipers shown in Fig. 3 are constructed upon the same principle that is, are, in effect, the same instrument as shown in Fig. 1, except that the arms 30 30 and 40 40 are curved instead of being straight, as shown in Fig. 1. The surface of the arms of the calipers or divider may be provided with the usual scale indicating the proportions or relative sizes to which the device may be adjusted.

The inventor is Mr. Antonio Bosola, of New York City.

It is always better to start a good thing late, than not at all—it is, just get into the habit of reading "The Draftsman". If you get the habit we will send you "The Draftsman for five years for $3.00.

Summer School for Arrtisans.

The fourth annual sessions of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27th, and continues for a period of six weeks.

FREDERICK E. TURNEAURE,
Dean College of Engineeriing,
Madison, Wis.

Draftsmanship and Ingraving.

In view of the demand for free-hand draftsmen in pen and ink line drawing which may be adapted to processes of engraving, Professor George Hartnell Bartlett, principal of the Normal Art School of Boston, has issued a practical book of instruction intended to lead ambitious students to help themselves.

The text includes eleven papers on line drawing, a brief history of the earlier arts of illustration and expositions of the processes of drawing and engraving on wood, steel and copper plate engraving, lithography, zincography, albertype process, zinc process, half-tone etching on copper and three-color process. It concludes with two readable essays on "Nature the Great Source of Inspiration for Composition" and "Art and Art Schools."

Professor Bartlett's instruction is first of all practical and to the point. He speaks with authority in clear English that may not be misunderstood. The histories of the early arts of engraving of the days of Durer and Holbein are pithy as well as interesting. A charming simplicity of diction leads the student to read facts and technical explanations which under other phraseology might be dry and uninstructive. A spirit of encouragement illuminates the lessons, while pertinent advice is given from the standpoint of generous criticism.

(H. O. Houghton & Co. The Riverside Press, Cambridge, Mass.)

K & E Vertical Cylindrical Electrical Print Frame.

This cylindrical apparatus consists of two sections of curved glass, each mounted in a metal casing and together forming a cylinder which rotates on a circular base. It requires a floor space of about 36 x 42 inches. The lamp is suspended in the axial line of the cylinder, where it travels by clock-work with electric motive force.

Tracing and paper are placed on the outer surface of the glass cylinder, where they are held by a canvas curtain mounted on a vertical roller attached to the upright which carries also the lamp and the mechanism for moving it. This curtain is wound on to the cylinder by rotating the cylinder on its base, which is done by a conveniently placed handwheel. It is held tense by the roller spring and a foot brake on the base plate, which arrests the cylinder. The rotating of the cylinder therefore automatically winds the curtain on to it and holds the tracings and paper in very good contact. The feeding in of the tracing and paper is easily and quickly accomplished, and there is no tilting of the glass cylinder. The unwinding of the curtain is done by means of the handwheel assisted by the spring acting on the curtain roller.

The lamp is of a special pattern to give perfect diffusion and distribution of light. It is moved by clockwork and can be set to any required speed, to any distance of travel, and to start from and stop at any point. The current is cut off automatically at the end of the travel of the lamp.

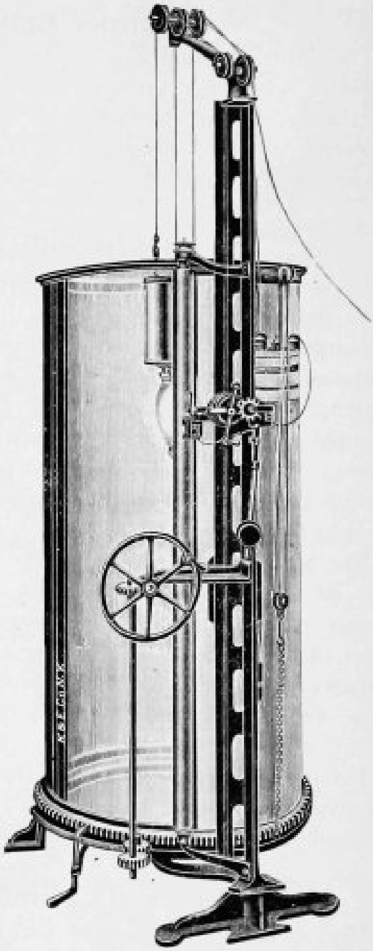
This is a very economical apparatus because it requires only one lamp, even for large tracings. Tracings and paper can be inserted and removed very quickly and conveniently. It is much less liable to accidental breakage than the similar cylinders which swing in pinions and are placed horizontal to load them. Besides they require less floor space.

These frames can be furnished with lamps for either direct or alternating current, 110 or 220 volts.

We furnish these frames all complete, ready to connect with the feed wire and can furnish them from stock at short notice.

KEUFFEL & ESSER CO.,

Drawing Materials, Surveying Instruments, Measuring Tapes. 127 Fulton St., New York.

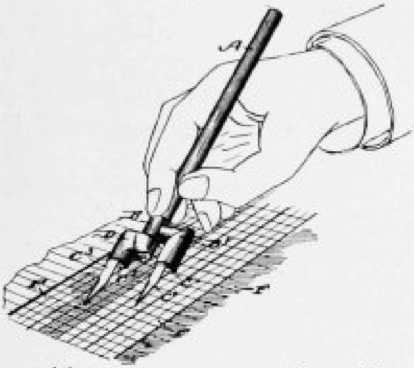


The Deepest Hole in the World.

The deepest boring yet made is at the village of Schladebach, near the line between Leipzig and Corbetha. It has been made by the Prussian government to test for the presence of coal, and was bored with diamond drills. Its depth is 1,390 metres (4,560 feet); its breadth at the bottom two inches, and at the top eleven inches. It has occupied three and a half years to bore, and cost a little over £5,000 sterling. The temperature at the bottom is 118 degrees Fahrenheit. —*Scientific American.*

An Improved Penholder.

R. R. B. McBEE, of Ardmore, Ind. Ter., has invented and patented a useful penholder which is an improvement on posting-pens, the object being a pen having a double point and adapted to simultaneously write duplicate columns of figures, and which is also capable of being used



in writing across a page, thus giving duplicate lines one below the other.

By placing a memoranda slip so that its edge will lie adjacent and parallel to the line on which the matter is to be written, a duplicate column of figures may be recorded.

DEATHS.

Mr. Edwin Horatio Fowler died at his residence, 1126 East Capitol St., after a brief illness. Mr. Fowler was chief draftsman of the United States Coast and Geodetic Survey, and had been identified with Washington life and affairs for more than a quarter of a century.

George Bryan, a draftsman in the employ of Harry Wachter, architect, died at St. Vincent's hospital after an illness of three weeks as the result of a complication of diseases. Mr. Bryan came to Toledo eight years ago, and since that time had worked for most of the architects here.

Harry Lindon, draftsman in the employ of the Reading Coal & Iron Co., died at Reading, Pa., having been struck by an engine.

To an electrician one horsepower is 746 watts.

The fiercest of all animals are the black panthers.

Two-thirds of the world's sugar is made from beets.

Of 1,200 locomotives in use in Japan, 500 are American made.

The largest oilship in the world, the Narragansett, has just been launched in the Clyde. She will hold 10,000 tons of oil, which can be discharged at the rate of 900 tons an hour.

There are 227 lead pencil factories in Germany, which employ 2,813 persons, and export each year 1,614 tons of pencils, worth $2,000,000.

Nearly all the safety matches which are safe against friction on sandpaper, stone, wood, or brick, ignite readily from a quick rub on glass.

Malta is the most thickly populated island in the world. It has 1,360 people to the square mile. Barbados has 1,054 people to the square mile.

World's Fair Facts.

The Holland submarine torpedo boat will navigate under the waters of the lagoons.

Nearly a hundred and fifty millions of feet of lumber were used in building this great World's Fair.

Among the kings who will visit the Exposition are: King Menelik, of Abyssinia; the King of Siam; Somdotoh Chowfa Moha Vagiravudh, Crown Prince of Siam, and Ibrahim, Sultan of Johore.

The foreign governments will be strongly represented. Germany and France are spending over $1,000,000 each; Brazil, $600,000; Great Britain, Mexico, China and Japan each over $500,000.

The Philippine exhibit covers forty acres, showing the commerce and industries of the islands. Includes native workmen and material, tribesmen, their families and huts, land and water vehicles, and a typical Manila street.

Five hundred thousand incandescent electric lamps will be employed in the illumination of the World's Fair grounds and buildings.

The largest glass bottle ever made in the world will be exhibited at the World's Fair, St. Louis, this year. It was blown in the plant of the Illinois Glass Co., at Alton, Ill.

MEANT WHAT SHE SAID.

Miss Utaplace—"Allow me to introduce you to my perspective husband."

Miss Parcavenue—"You mean your 'prospective husband,' don't you?"

Miss Utaplace—"I mean exactly what I say. He's a draftsman."—*Baltimore American.*

TROUBLE.

Trouble's comin' soon enough.
I'se a-gwine to wait.
Won't rush f'um de front room do'
To meet it at de gate.
If it's out to catch you,
'Tain' much use to run;
So you might as well be happy
While you has a chance foh fun.

Trouble's mighty curious.
Don't wear out a bit.
De mo' of it you has, de mo'
You's liable to git.
An' yet it's mighty timid;
You'll learn it after while.
Like dem microbes in de sunshine,
You kin kill it wif a smile.

—*Washington Star.*

TRAIN TIME.—Nextholidayatwhichthisyearstops is Decoration Day.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Device for Gas Engines.

A simple device for a gas engine is shown in Figs. 1 and 2, that will act as a governor, and stop the engine, should the water that keeps the cylinder cool be for any reason shut off.

It was not gotten up for something new to manufacturer, nor is it for sale, but came about through the carelessness of the boy whose business it is to start the power going and keep a look out if anything should happen to it.

The engine under consideration is of the type using a gas jet to ignite the charges. The boy, no matter how often he was told would forget to turn on the water when he started the engine, and of course the cylinder would get hot in a few minutes and the engine would not go. It was then necessary to turn the water on and wait till

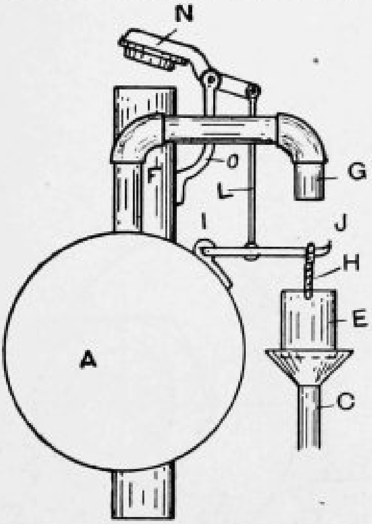


FIG. 1.

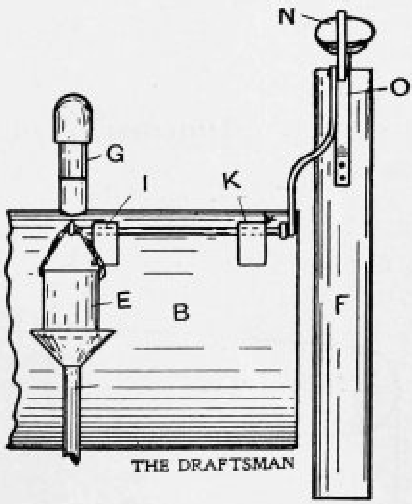


FIG. 2.

the engine had time to get cool, stopping all the machines for at least fifteen minutes. Something had to be done or the engine would be ruined.

Referring to the sketches, Fig. 1 is a sectional elevation looking from the crank end, and Fig. 2 is a part side elevation. The sketches are not uniform and are merely given to show the principal of the water cut-off.

A & B represent the cylinder, f the lamp chimney or igniting tube, g the pipe through which the warm water is discharged from the jacket of the cylinder, and C the funnel topped waste pipe carrying off the water.

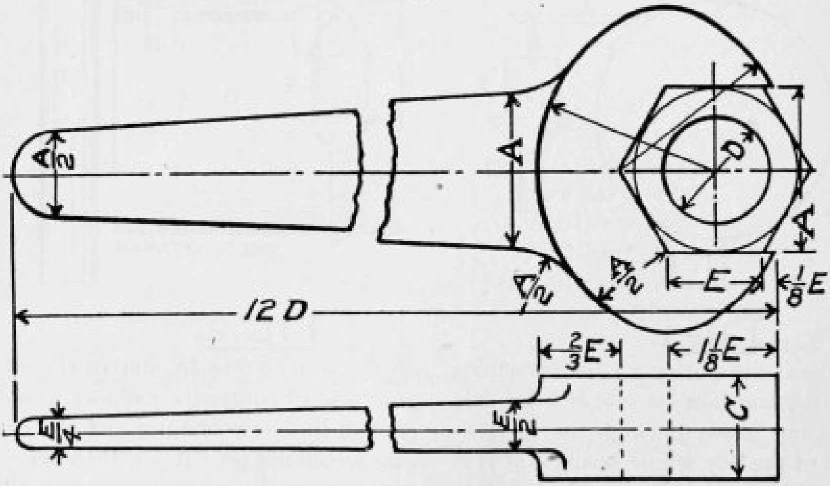
The rod J has a crank at each end and is carried in bearings i and k.

The tin cup e is hung by a small chain bale to the crank rod at J, directly under the drop of the stream of water from the pipe g to the waste pipe c. The tin cup e has a nail hole in the bottom. At the opposite end of the rod J, is a shorter crank to which the rod l is pivoted at its lower end. A bearing o is fastened to f, having at its upper end the pivoted cover n to the igniting tube f. The cover n is shown raised as it is when the engine is running. The igniting jet can not be lighted when this lid is down, and if raised and the gas lighted, it will go out the instant it closes the top of the tube. Before the engine can be started, the water must be turned on, fill up the jacket and overflow through g, fall into and fill up the tin cup, which form a weight to raise the cover n. The can gets full and runs over in the funnel, but if the water be turned off, the water in the cup leaks through the nail hole in bottom, reducing the weight until it will hold the cover n no longer, when it closes the top of f, and stops the engine.

Dimensions of Open End Wrench.

A = 1½ D.

D = Diam. of Bolt.



MECHANICAL.

The Economy of the Slide Rule.

CARL G. BARTH, M. E.

The Invention of Slide Rule for Accurately Fixing the Feed and Speed of Power-Driven Machine Tools is one of the Most Useful Economical Assets in Factory Management.

* * *

In a paper on "Shop Management," read at the Saratoga meeting of the society in June last, Mr. Fred W. Taylor referred to certain slide rules that had been invented and developed under his supervision and general guidance, by means of which it becomes a comparatively simple matter to determine that feed and speed at which a lathe or kindred machine tool must be run in order to do a certain piece of work in a minimum of time.

These slide rules were also mentioned by Mr. H. L. Gantt in his paper, "A Bonus System of Rewarding Labor" (New York meeting, December, 1901), as being at that time in successful use in the large machine shop of the Bethlehem Steel Company, and reproductions of a number of instruction cards were therein presented, the dictated feeds and speeds of which had been determined by means of these slide rules.

Mr. Taylor early set about making experiments with a view to obtaining information, in regard to resistances in cutting steel with edged tools, and also the relations that exist between the depth of cut and feed taken to the cutting speed and time that a tool will endure; and he advanced far enough along these lines in his early position as engineer for the Midvale Steel Company to make systematic and successful use of the information obtained; but as this, of course, was confined to tempered carbon tools only, it was not applicable to the modern high-speed steel, so that the invention and introduction of this steel called for new experiments to be made.

These were first undertaken under Mr. Taylor's directions at Bethlehem, so far as the cutting of steel alone was concerned; and later on at the works of William Sellers & Co., Inc., of Philadelphia, at which place the writer spent 15 months in going over these experiments again, on both steel and cast iron, and with tools of a variety of shapes and sizes, for which nearly 25 tons of material were required.

However, it is not the writer's intention at this time to give an account of these experiments, or of the results obtained and conclusions drawn from them, but merely to give some idea of the slide rules on which these have been incorporated, and by means of which a most complex mathematical problem may be solved in less than a minute.

He will also confine his attention to

the most generally interesting of these slide rules; that is, the slide rules for lathes, and he will take for an example an old style belt-driven lathe, with cone pulley and back gearing.

Considering the number of variables that enter into the problem of determining the most economical way in which to remove a required amount of stock from a piece of lathe work, they may be enumerated as follows:

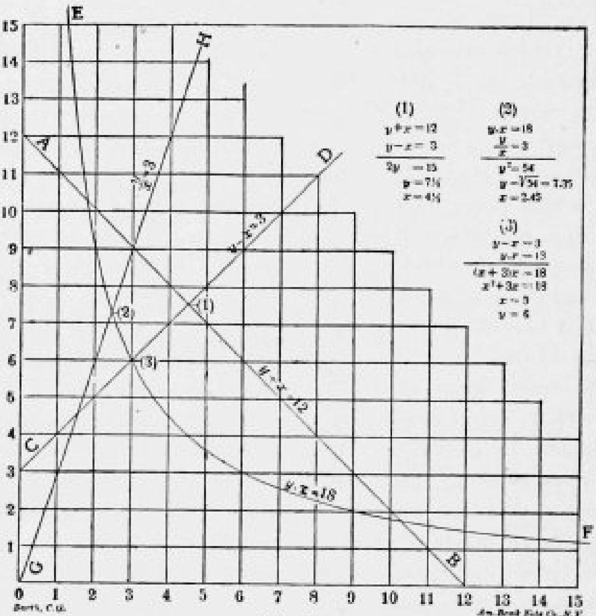


FIG. 1.

I. The size and shape of the tools to be used.

II. The use or not of a cooling agent on the tool.

III. The number of tools to be used at the same time.

IV. The length of time the tools are required to stand up to the work (Life of Tool).

V. The hardness of the material to be turned (Class Number).

VI. The diameter of this material or work.

VII. The depth of the cut to be taken.

VIII. The feed to be used.

IX. The cutting speed.

X. The cutting pressure on the tool.

XI. The speed combination to be used to give at the same time the proper cutting speed and the pressure required to take the cut.

XII. The stiffness of the work.

All of these variables, except the last one, are incorporated in the slide rule, which, when the work is stiff enough to permit of any cut being taken that is within both the pulling power of the lathe and the strength of the tool, may be manipulated by a person who has not the slightest practical judgment to bear on the matter; but which as yet, whenever the work is not stiff enough to permit of this, does require to be handled by a person of a good deal of practical experience and judgment.

However, we expect some day to accumulate enough data in regard to the relations between the stiffness of the work and the cuts and speeds that will not produce detrimental chatter, to do without personal judgment in this matter also, and we will at present take no notice of the twelfth one of the above variables, but confine ourselves to a consideration of the first eleven only.

Of these eleven, all except the third and tenth enter into relations with each other that depend only on the cutting properties of the tools, while all except the second, fourth and ninth also enter into another set of relations that depends on the pulling power of the lathe, and the problem primarily solved by the slide rule is the determination of that speed-combination which will at the same time most nearly utilize all the pulling power of the lathe on the one hand, and the full cutting efficiency of the tools on the other hand, when in any particular case under consideration values have been assigned to all the other nine variables.

If our lathe were capable of making any number of revolutions per minute between certain limits, and the possible torque corresponding to this number of revolutions could be algebraically expressed in terms of such revolutions, then the problem might possibly be reduced to a solution, by ordinary algebraic methods, of two simultaneous equations containing two unknown quantities; but as yet no such driving mechanism has been invented, or is ever likely to be invented, so that, while the problem is always essentially the solution of two simultaneous equations or sets of relations between a number of variables, its solution becomes necessarily a tentative one; or, in other words, one of trial and error, and involving an endless amount of labor, if attempted by ordinary mathematical methods; while it is a perfectly direct and remarkably simple one when performed on the slide rule.

The slide rule method of solution may, however, also be employed for the solution of numerous similar problems that are capable of a direct and perfect algebraic solution; and it will, in fact, be best to exhibit the same in connection with the simplest imaginable problem of this kind.

In the first place, the solution of two simultaneous equations may be graphically effected by representing each of them by a curve whose coördinates represent possible values of the two unknown quantities or variables, for them the coördinates of the point of intersection of these curves will represent values of the unknown quantities that satisfy both equations at the same time.

Example 1. Thus, we have $y + x = 12$ and $y - x = 3$ these equations are respectively represented by the two straight lines AB and CD in Fig. 1; and as these intersect at a point (1) whose coördinates are $x = 4\frac{1}{2}$ and $y = 7\frac{1}{2}$, these values will satisfy both equations at the same time.

Example 2. Suppose again that we have $x.y = 18$ and $y = 3$ and these equations are respectively represented by the equilateral hyperbola EF and the straight line

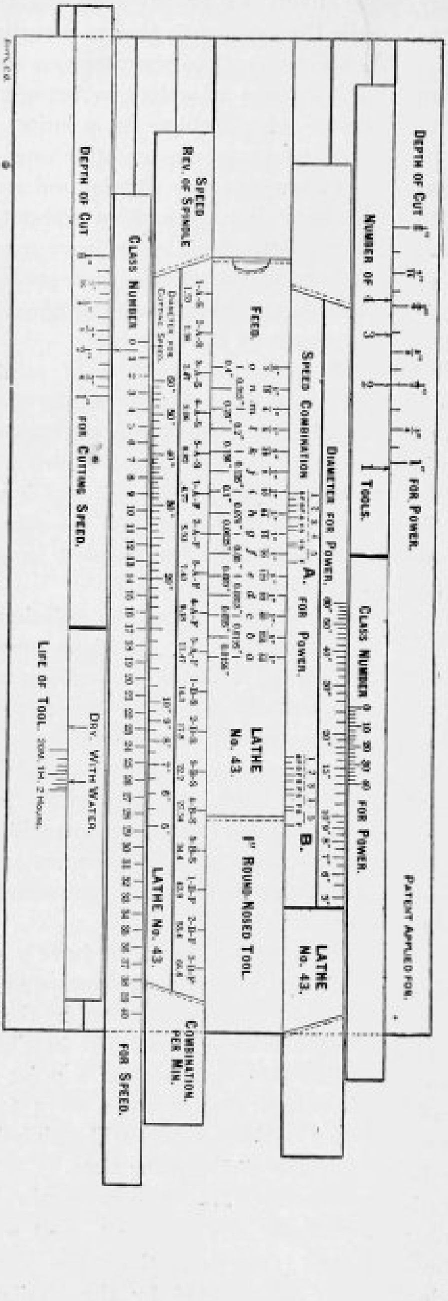

DEPTH OF CUT FOR POWER.
NUMBER OF TOOLS.
CLASS NUMBER FOR POWER.
PATENT APPLIED FOR.
DIAMETER FOR POWER.
SPEED COMBINATION A. FOR POWER.
B.
LATHE No. 43.
FEED.
LATHE No. 43.
1" ROUND-NOSED TOOL.
SPEED REV. OF SPINDLE
LATHE No. 43.
COMBINATION. PER MIN.
CLASS NUMBER
FOR SPEED.
DEPTH OF CUT FOR CUTTING SPEED.
DRY. WITH WATER.
LIFE OF TOOL.

FIG. 3

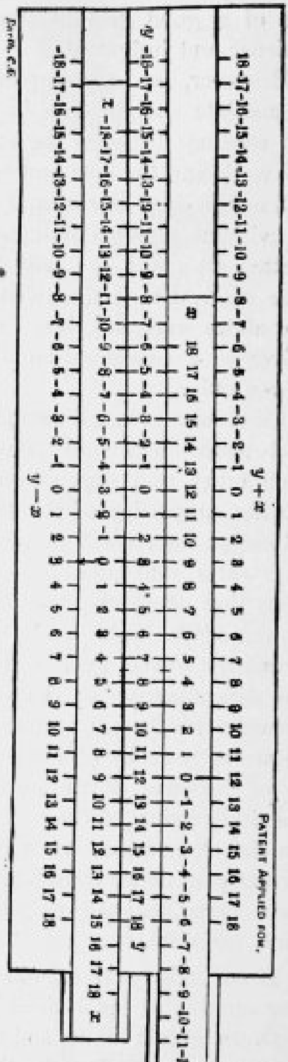

y + x
PATENT APPLIED FOR.
y − x

FIG. 2.

GH; and the coördinates to the point of intersection of these (2) being respectively x = 2.45 and y = 7.35; these values will satisfy both equations at the same time.

Example 3. Similarly, if we have y — x = 3 and y.x = 18 these equations are respectively represented by the straight lines CD and the equilateral hyperbola EF; and the coördinates to the point of intersection of these (3) being x = 3 and y = 6, these values will satisfy both equations at the same time.

The slide rule method of effecting these solutions—to the consideration of which we will not pass—will readily, be seen to be very similar in its essential nature to this graphical method though quite different in form.

In Fig. 2 is shown a slide rule by means of which may be solved any problem within the range of the rule of the general form: "The sum and difference of two numbers being given, what are the numbers?"

The rule is set for the solution of the case in which the sum of the numbers is 12 and their difference 3, so that we may write

y + x = 12 and y—x = 3.

which are the same as the equations in Example 1 above.

In the rule the upper fixed scale represents possible values of the sum of the two numbers to be found, for which the example under consideration gives y + x = 12 opposite which number is therefore placed the arrow on the upper slide.

The scale on this slide represents possible values of the lesser of the two numbers (designated by x) and the double scale on the middle fixed portion of the rule represents possible values of the greater of the two numbers (designated by y); and these various scales are so laid out relatively

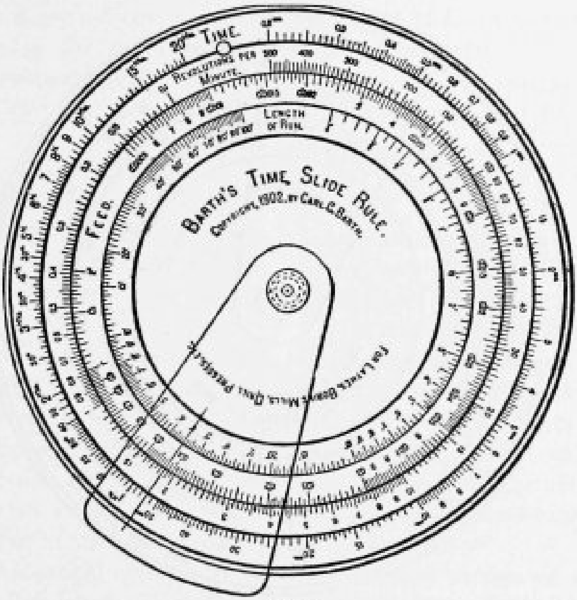


Fig. 4.

to each other and to the arrow referred to, that any two coincident numbers on these latter scales have for their sum the number to which this arrow is set; in this case accordingly 12.

The bottom fixed scale on the rule represents possible values of the difference of the two numbers in this case 3, opposite which number is therefore placed the arrow on the bottom slide of values coincident to it in the two x scales on the slides; and this done, we readily discover in which direction we must move along the first scale in order to pick out that value of y which has the same value of x coincident with it in both x scales. For the case under consideration this value of y is 7½, and the coincident value in both scales is 4½. Evidently, therefore, y = 7½ and x = 4½ are the numbers sought.

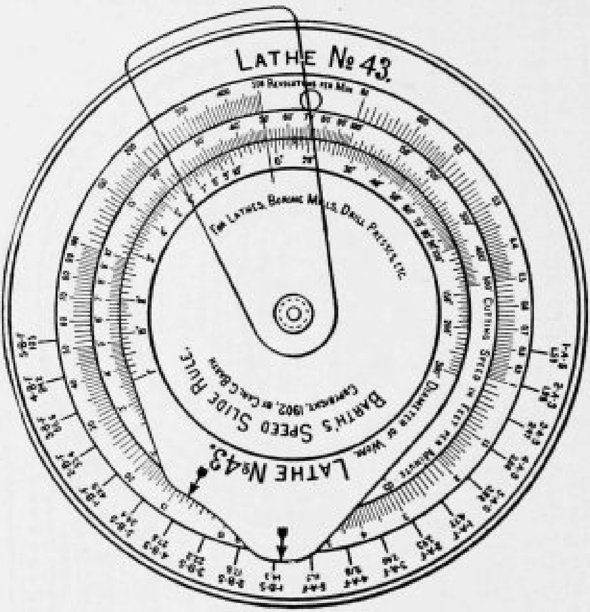


Fig 5.

the lesser of the two numbers, x; and the double fixed scale in the middle of the rule represented as already pointed out, possible values of y, the whole is so laid out that any two coincident numbers on these latter scales have for their difference the number to which this arrow is set; in this case accordingly 3.

Fixing now our attention on any number on the double y scale in the middle of the rule, we first note the

In the same manner we make a slide for Power became coincident with 14 rule for the solution of the general problem: "The product and quotient of two numbers being given, what are the numbers?"

Such a rule would differ from the above described rule merely in having longarithmic scales instead of plain arithmetic scales.

By the combined use of both arithmetical and logarithmic scales we may even construct rules for a similar solution of the general problems: "The sum and product, or the sum and quotient, or the difference and product, or the difference and quotient, of two numbers being given, what are the numbers?" and a multiplicity of others; and the writer ventures to suggest that slide rules of this kind, and some even simpler ones, might be made excellent use of in teaching the first elements of algebra, as they would offer splendid opportunities for illustrating the rules for the operations with negative numbers, which are such a stumbling block to the average young student.

We now have sufficient idea of the mathematical principles involved, for a complete understanding of the working of the slide rule whose representation form the main purpose of this paper.

This slide rule, in a somewhat ideal form in so far as it is made out of neither steel nor cast iron, but for an ideal metal of properties between these two, is illustrated in Fig. 3. It will be seen to have two slides in its upper section and three in its lower section, and is in so far identical with the rules made for the Bethlehem Steel Company, while in the rules more recently made it had been found possible and convenient to construct it with only two slides in the lower section also.

It is shown arranged for a belt-driven lathe with five cone steps, which are designated respectively by the numbers 1, 2, 3, 4, 5, from the largest to the smallest on the machine. This lathe has a back gear only, and the back gear in use is designated by the letter A, the back gear out by the letter B. It also has two counter-shaft speeds, designated respectively by S and F, such that S stands for the slower, F for the faster of these speeds.

The Speed Combination 3 — A — S thus designates—to choose an example—the belt on the middle cone step, the back gear in, and the slow speed of the counter-shaft; and similarly, the combination 1 — B — F designates the belt on the largest cone step on the machine, the back gear out, and the fast speed of the counter-shaft; and so on.

The double, fixed scale in the middle of the rule (marked Feed) is equivalent to the y scale of the rule in Fig. 2, and the scales nearest to this on the slides on each side of it (marked Speed Combination for Power, and for Speed respectively) are equivalent to the x scales on the rule in Fig. 2. The rest of the scales represent the various other variables that enter into the problem of determining the proper feed and speed combination to be used, fixed values being either directly given or assigned to these other variables, in any particular case under consideration.

The upper section of the rule embodies all the variables that enter the question of available cutting pressure at the tool, while the lower section embodies all the variables that enter into the question of cutting speed; or, in other words, the upper section deals with the pulling power of the lathe, the lower section with the cutting properties of the tool; and our aim is primarily to utilize, in every case, both of these to the fullest extent possible.

The example for which the rule has been set in the illustration is:

A ½-inch depth of cut to be taken with each of two tools on a material of class 14 for hardness, and of 20 inches diameter, and the tools to last 1 hour and 45 minutes under a good stream of water.

The steps taken in setting the rule were:

1. The first scale in the upper or Power section of the rule, from above, was first set so that 2 in the scale marked Number of Tools became coincident with ½ inch in the fixed scale marked Depth of Cut for Power.

2. The second slide in this section of the rule was so set that 20 inches in the scale marked Diameter of Work in the scale marked Class Number for Power.

3. The first slide from below, in the lower or Speed section of the rule, was so set that the arrow marked With Water became coincident with 1 hour 45 minutes in the fixed scale marked Life of Tool.

4. The arrow on the lower side of the second slide in this section of the rule was set to coincide with ½ inch in the scale marked Depth of Cut for Cutting Speed.

5. The third and last slide in this section was so set that 20 inches in the scale marked Diameter of Work for Cutting Speed became coincident with 14 in the scale marked Class Number for Cutting Speed.

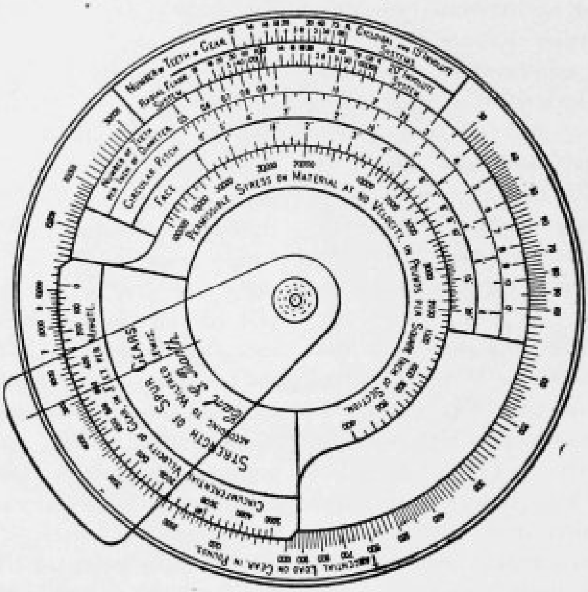


FIG. 6.

Let us now separately direct our attention to each of the two sections of the rule.

In the Power section we find all of the speed combinations marked B (back gear out) entirely beyond the scale of feeds, which means that the estimated effective pull of the cone belt reduced down to the diameter of the work does not represent enough available cutting pressure at each of the tools to enable a depth of cut of ½ inch to be taken with even the finest feed of the lathe. Turning, however, to the speed combinations marked A (back gear in), we find that with the least powerful of them (5—A—F) the e feed, which amounts to 5-128 inch = 0.039 inch, may be taken; while the f feed, which amounts to 1-20 inch = 0.05 inch, is a little too much for it, though it is within the power of the next combination (5—A—S), and so on until we finally find that the most powerful combination (1—A—S) is nearly capable of pulling the i feed, which amounts to 1-10 inch = 0.1 inch.

In the Speed section of the rule we likewise find that all the B combinations lie beyond the scale of feeds, while we find that the combination 5—A—F (which corresponds to a spindle speed of 11.47 revolutions per minute), can be used in connection with the finest feed (a) only, if we are to live up to the requirements set for the life of the tool; while the next combination (4—A—F) will allow of the e feed being taken, the combination 3—A—F of the f feed, and so on until we finally find that the combination 3—A—S is but a little too fast for the coarsest (o) feed, and that both of the slowest combinations (1—A—S and 2—A—S) would permit of even coarser feeds being taken so far as only the lasting qualities of the tools are concerned.

We thus see that there is a vast difference between what the Power section of the rule gives as possible combinations of feeds and speeds for the utilization of the full pulling power of the lathe, and what the Speed section of the rule gives for such combinations for the utilization of the tools up to the full limit set. However, by again running down the scale of feeds we find that, in both sections of the rule, the i feed (0.1 inch = 0.1 inch) is but a trifle too coarse for the combination 1—A—F, while the b feed (5-64 inch = 0.078 inch) is somewhat too fine in connection with this speed combination 1—A—F, both for the full utilization of the pulling power of the belt on the one hand, and for the full utilization of the cutting efficiency of the tools on the other hand.

In this case, accordingly, the rule does not leave a shadow of doubt as to which speed combination should be used, while it leaves us to choose between two feeds, the finer of which does not allow us to work up to the full limit of either the belt or the tools, and the coarser of which will both overload the belt a trifle and ruin the tools a trifle sooner than we first intended to have them give out.

The final choice becomes a question of judgment on the part of the slide rule and instruction card man, and will depend upon how sure he is of having assigned the correct class number to the material or not; and this latter consideration opens up a number of questions in regard to the practical utilization of the rule, which for the lack of time cannot be taken up in the body of this paper, but which will be fully answered by the writer in any discussion on the subject that may arise.

Having decided upon the speed and now turns to the Time slide rule illus-feed to use, the instruction card man trated in Fig. 4, and by means of this determines the time it will take the tools to traverse the work to the extent wanted, and making a fair allowance for the additional time consumed in setting the tools and calipering the work, he puts this down on the instrument card as the time the operator should take.

For finishing work the pulling power cuts no figure, so that this resolves itself into a question of feed and speed only; and for the selection of the speed combination that on any particular lathe will give the nearest to a desired cutting speed, the speed slide rule illustrated in Fig. 5 is used.

It will be readily realized that a great deal of preliminary work has to be done before a lathe or other machine tool can be successfully put on a slide rule of the kind described above. The feeds and speeds and pulling power must be studied and tabulated for handy reference, and the driving belts must not be allowed to fall below a certain tension, and must, in every way, be kept in first-class condition.

In some cases it also becomes necessary to limit the work to be done, not by the pull that the belts can be counted on to exert, but by the strength of the gears, and in order to quickly figure this matter over the writer also designed the Gear slide rule illustrated in Fig. 6, which is an incorporation of the formulæ established several years ago by Mr. Wilfred Lewis.

For the pulling power of a belt at different speeds, the writer has established new formulæ, which take account of the increasing sum of the tensions in the two slides of a belt with increasing effective pull, and which at the same time are based on the tensions recommended by Mr. Taylor in his paper entitled, "Notes on Belting," which was presented at the meeting of the society in December, 1893.

These formulæ have also been incorporated on a slide rule, but as the writer hopes at some future time to prepare a separate paper on this subject, he will not go into this matter any further at the present time.

Having thus given an outline of the use of the slide rule system of predetermining the feeds and speeds, etc., at which a machine tool ought to be run to do a piece of work in the shortest possible time, the writer, who has made this matter an almost exclusive study during the last four years, and who is at present engaged in introducing the Instruction Card and Functional Foremanship System into two well-known Philadelphia machine shops, which do a great variety of work in both steel and cast iron, will merely add, that in view of the results he has already obtained, in connection with the results obtained at Bethlehem, the usual way of running a machine shop appears little less than absurd.

Thus already during the first three weeks of the application of the slide rules to two lathes, the one a 27-inch, the other a 24-inch, in the larger of these shops, the output of these was increased to such an extent that they quite unexpectedly ran out of work on two different occasions, the consequence being that the superintendent, who had previously worried a good deal about how to get out the great amount of work on hand for these lathes out of the way, suddenly found himself confronted with a real difficulty in keeping them supplied with work. But while the truth of this statement may appear quite incredible to a great many persons, to the writer himself, familiar and impressed as he has become with the great intricacy involved in the problem of determining the most economical way of running a machine tool, the application of a rigid mathematical solution of this problem as against the leaving it to the so-called practical judgment and experience of the operator, can not otherperfect folly of the latter method.—Mill Owners.

Boiler Details

Boiler walls will crack, and no form of construction seems to entirely prevent this. Walls with air spaces are as liable as those without, with the danger of leaking more air when they do crack.

The best method to hold boiler walls together is with "buck-stays" or "buck-bars."

The best form is railway iron with ends mashed down under the hammer to allow for drilling holes for tie-rods. Most builders do not supply "brick-stays" unless specially ordered.

Generally, two brick-stays on each side and two on the ends will answer for boiler walls but three on each side would be much better.

SIZES OF BUCK-STAYS.

A	B	C	D	E	F	G	H
6—2	5	$3\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{11}{16}$
8—9	$5\frac{1}{2}$	$3\frac{3}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{11}{16}$
10—2	6	4	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	3	$\frac{13}{16}$

The illustration shows some sizes which the writer has seen used though it should be kept in mind that those placed on the end walls should have holes of a distance apart to match the casting containing the fire doors, in front.

The tie rods are usually ⅝ or ¾, and on large boilers ⅞ inches in diameter, and all sizes should be threaded on both ends, for square or hexagon nuts.

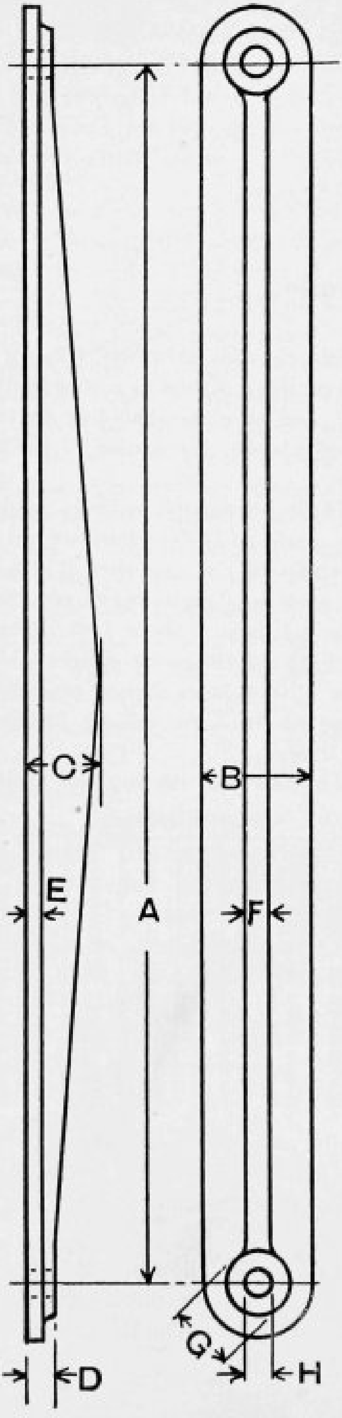
There is common sense in applying lugs made of boiler plate to steel boiler shells for their support. These lugs are made of flange steel 60,000 lbs. T. S. which is just about four times the strength of the same weight of cast iron. Rivet holes may be punched instead of the slow drilling process, if preferred.

The fact that the lug and shell are of the same grade of material prevents all possibility of leaky rivets due to unequal expansion of cast lug and steel shell.

SIZES IN STOCK.

Diameter of Boiler Shell.	Height from Center of Boiler to Base of Lug.	Width of Lug, Inches.	Length, Inches.	Height, Inches.	Thickness, Inches.	Weight, Each (lbs.)	Equivalent to lbs. of Cast Iron.
38	5	6	9	7	1-4	10	40
42	5	6	9	7	1-4	10	40
44	6	7	11	8½	9-32	15	60
48	6	7	11	8½	9-32	15	60
54	7	9	13	10	5-16	24	100
60	7	9	13	10	5-16	24	100
66	8	10	15	11	3-8	38	150
72	8	10	15	11	3-8	38	150
78	9	10	15	11	3-8	38	150
84	9	10	15	11	3-8	38	150

From the following table, the designer will have dimensions for the sizes and position on the boiler.



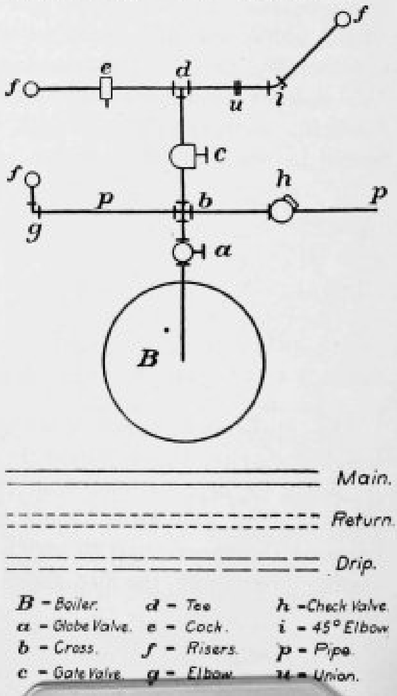
Two lugs on each side of the boiler will be sufficient, except in very long boilers where three would be better.

This style of lug known as the Drake-Castle Boiler Lug is carried in stock by Joseph T. Ryerson & Son, Chicago, Ill.

The conventional manner of showing pipe and fitting here produced is one shown on a supplement of

—*Machinery*.

Conventional Pipe Fittings.



Friction.

THE laws of friction are:

(1.) *It varies directly as the pressure between the surfaces in contact.*

2.) *It is independent of the extent of the surface in contact.*

(3.) *It is independent of the velocity, when the surfaces are in motion.*

These laws are, in actual practice, only approximately true; the first law not holding in the case where the pressures are very great, and the third law not holding beyond a velocity of about 150 feet per minute.

DIFFERENCE BETWEEN SLIDING AND ROLLING FRICTION.—"In rolling friction, the surface of at least one of the two bodies in question is bounded by a circular line, and the point of contact between the two bodies is thus reduced to a minimum. The particles in contact during the movement are also not *dragged along*, but *put down and lifted up*, by the rotary, or circular movement of the body, and the friction of sliding is avoided."

LAW OF ROLLING FRICTION.—In *rolling* friction, the friction is regulated not only by the pressure, but by the diameter of the rolling body. *The smaller the diameter of the body, the greater the friction.* Where the balls or cylinders are of the same substances, the law for rolling friction is: "*Rolling friction is directly as the pressure, and inversely as the diameter of the rolling bodies.*"

The above law, however, only applies to traction, where the load is moved by a direct pull or push on the axis of the rolling body—as in the case of a wagon or car; but, where the load is propelled by a crank fixed on the axle of the rolling body, *the law as defined is reversed;* for, in this case the smaller the diameter of the rolling body, the less the friction. For example: It is desired to move a freight train at the least expense of power. To accomplish this, the driving wheels on the locomotive are reduced, and the wheels on the cars increased; since the former propels, whilst the latter are propelled.

DATA.

Rolling friction:

Locomotive on dry rails at speed of about 10 miles per hour = 1-5th total weight. As the speed is increased, the adhesion is reduced.

Street cars on iron rails = 15 pounds per ton when rails are wet and clean, straight and new; 30 pounds per ton under average conditions.

Sliding Friction:	Co-Efficient. Ordinary Lubrication	Co-Efficient. Continues Lubrication
Cast iron in cast iron / Cast iron in gun metal,	Average, 075 or $\frac{1}{13.3}$	
Wrought iron in cast iron, / Wrought iron in gun metal,	Average, 042 or 1-24th.	
Gun metal in gun metal; ordinary	.10 or 1-16th.	

ARCHITECTURAL.

Railway Freight Houses and Yards.

In a copy of *The Railway Age* is found the discussion of sizes of railway freight houses and necessary space around them for wagons and the following information was furnished by the representative of the different railroads present:

Philadelphia & Reading Railway.—The following information has been furnished by Mr. W. G. Besler, general superintendent:

1. Width of inbound and outbound freight houses 37 feet.

2. Width of platform along outside of freight houses 6 feet.

3. Width of platform for trucking between tracks 15 feet.

4. Width of driveways in yards where one or both sides are used for loading or unloading (clear width between sides of cars) about 26 feet.

5. Width of driveways at freight stations, where one or both sides are used for loading or unloading. At Thirteenth and Callowhill streets the width between inbound and outbound buildings is 60 feet.

6. Street grade in business district (average and maximum) 5 per cent.

7. Average and maximum loads of wagons; 2-horse teams, 2 net tons; some 3-horse teams haul 5 tons.

8. Total length of wagon, including horses, average, 26 feet 6 inches; maximum, 27 feet 6 inches.

9. Length of wagon with horses turned, average, 18 feet; maximum, 19 feet.

10. Width of wagon, over all: Average, 6 feet 2 inches; maximum, 6 feet 5 inches.

PITTSBURG.

Pittsburg & Lake Erie Railroad.—To Mr. J. A. Atwood, chief engineer, the committee is indebted for a set of sketch plans of all the freight stations in Pittsburg and Allegheny. As the actual layouts in various cities differ so widely (owing largely to local conditions), and as your committee's purpose is rather to lay down governing principles than to show actual existing plans, it has not been deemed advisable to reproduce these plans with the report. The following is a summary of the information given:

	Maximum.		Minimum.		Average.	
	Ft.	In.	Ft.	In.	Ft.	In.
Width of inbound and outbound freight houses	303	0	13	6	68	8
Width of platform along outside of freight houses	34	6	4	6	12	0
Width of platform for trucking between tracks	12	0	8	6	10	8
Width of driveways between tracks where one or both sides are used for loading or unloading (clear width between sides of car)	65	0	18	0	31	0
Width of driveways of freight stations where one or both sides are used for loading and unloading (only one in Pittsburg)	37	6	......	......	......	......
Street grades in business districts	3.7%		......	......	3%	
Average and maximum load of wagons						
Length of wagon including horses	28	6	22	0	24	3
Length of wagon with horses turned	16	6	12	6	14	6
Width of wagon all over	......	......	......	......	6	6

Southern Pacific Railway.—Mr. J. L. Frazier, superintendent, has furnished answers to the questions asked as nearly as practicable. There are a large number of freight sheds, which differ in width and length. The teams which handle freight vary in size from small wagons hauling 1,000 pounds or more, to immense 4-horse trucks hauling 10 tons. The surface of the city is much broken up; the business portion of it, however, is practically level.

1. Width of inbound and outbound freight houses 30 to 75 feet.

2. Width of platform along outside of freight houses 4½ to 5 feet.

3. Width of platform for trucking between tracks. None.

4. Width of driveways in yards, where one or both sides are used for loading or unloading (clear width between sides of cars) 40 to 45 feet.

5. Width of driveways at freight stations, where one or both sides are used for loading or unloading 48 to 51 feet.

6. Street grade in business districts. Average, .5 per cent.; maximum, 4½ per cent.

7. Average and maximum load of wagons 1 to 10 tons.

8. Total length of wagon, including horses, 20 to 40 feet.

9. Length of wagon with horses turned, 12 to 30 feet.

10. Width of wagons, over all 5½ to 9 feet.

-MEASUREMENT OF WAGONS AT CHICAGO.

No.	Total Length, Including Horses.	Length with Horses Turned, Feet.	Width, Feet.
1	29¾	17	7
2	22	12¾	7
3	26	15	7½
4	31	22	8¼
5	27	16	7½
6	27½	17½	7½
7	27½	17½	7
8	27	15¾	7½
9	28	15	7½
10	25	14	7
11	28	15½	7½
12	28	17	7¾
13	28	15½	7½
14	24	14½	7
15	25	15½	7½
16	25	15½	7¾
17	25	15½	7½
18	29½	19	6

Computing Strains in a Crane Derrick.

WILL you kindly publish in your paper or have Mr. Kidder give a method of computing the strains on the different parts of a crane derrick, as shown in the accompanying sketch, Fig. 1, and say if it would be practicable to build one of the dimensions indicated? The blocks on the boom would be on a carriage and run on the boom. The mast would be set on blocking 25 feet high. There would be four main guys from the top of the mast.

Answer.—We submitted the inquiry of our correspondent to Mr. Kidder, who furnishes the following: In reply to the question above I would say that it is practicable to construct a crane derrick as shown by the correspondent's sketch, provided the framework on which the mast sets is made sufficiently stiff to resist the horizontal thrust at the bottom of the mast, which is quite considerable. It will also be necessary to strengthen the mast by means of the "hog chain," as in Fig. 2. Otherwise the mast would break in two. The strains or stresses in the different parts of the derrick will vary with the position of the carriage on the boom, and will of course be greatest when the load is applied at the outer end of the boom. The derrick must be made strong enough to sustain the load in this position.

The stresses in the different parts

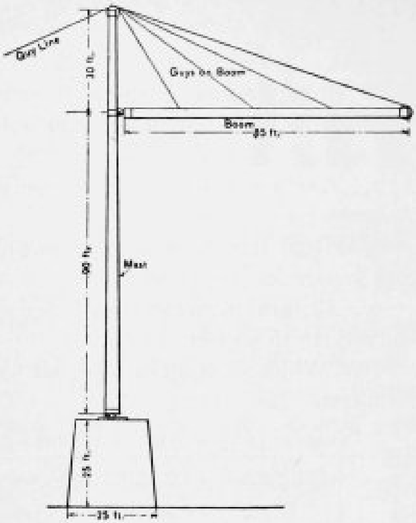


Fig. 1.—Diagram of Derrick Submitted by "H. G. R."

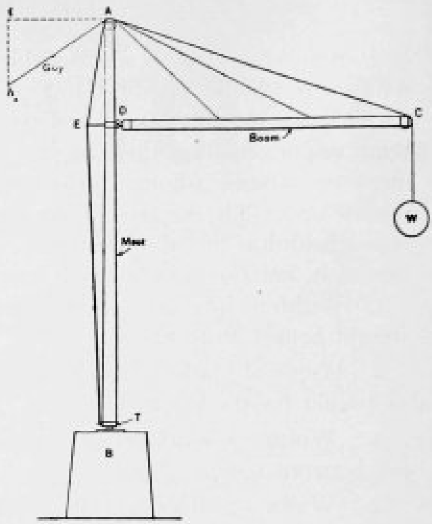


Fig. 2.—Diagram Contributed by Mr. Kidder.

Computing Strains in a Crane Derrick.

may be found as follows:

$$\text{Stress in boom} = \frac{\text{length C D.}}{\text{A D}} \times W$$

$$\text{Stress in A C} = \frac{\text{A C}}{\text{A D}} \times W$$

Stress in E D is the same as in the boom.

$$\text{Thrust, T, at the bottom of mast} = \frac{\text{CD}}{\text{A B}} \times W$$

$$\text{Stress in B E} = \frac{\text{BE}}{\text{ED}} \times T$$

$$\text{Stress in AE} = \frac{\text{AE}}{\text{ED}} \times (\text{stress in boom} - T)$$

$$\text{Compression in mast} = W + \frac{\text{BD}}{\text{D E}} \times T$$

All measurements should be in feet.

Application.—With the derrick in question, C D = 85; AD = 30; AC = 90.15; DB = 60. E D we will make 5 feet, which will give 60.2 for the length of B E and 30.4 for A E. We will assume W at 1000 pounds.

$$\text{The stress in boom} = \frac{85}{30} \times 1000 = 2833$$

pounds = stress in E D.

$$\text{Stress in A C} = \frac{90.15}{30} \times 1000 = 3005 \text{ bounds.}$$

$$\text{Thrust at B} = T = \frac{85}{90} \times 1000 = 944 \text{ pounds.}$$

$$\text{Stress in B E} = \frac{60.2}{5} = 944 = 11{,}365 \text{ pounds.}$$

$$\text{Stress in A E} = \frac{30.4}{5} \times (2833 - 944 = 11{,}485 \text{ lbs.}$$

$$\text{Compression in mast} = 1000 + \frac{60}{5} \times 944 =$$

12,428 pounds.

The boom and mast and strut *E D* are in compression; the other parts in tension. If *W* is 2000 pounds all of the stresses will be just twice as large —*i. e.*, the stresses will be in proportion to the load.

If the guy were horizontal the stress in it would be equal to *T*, provided the guy was in the same plane as the boom.

For an inclined guy the stress will be increased in the proportion that *A h* is greater than *A i*, or stress in

$$\text{guy} = \frac{\text{A h}}{\text{A i}} + T, \text{ h i being vertical.}$$

As the boom carries a traveling carriage it must be strong enough to resist both the compressive stress and the transverse stress, as a beam, when the carriage is half way between any two points of support.—"*Carpentry and Builder.*"

Making a Five-Pointed Star with the Steel Square.

A writer in *Carpentry and Builder,* says: "I send herewith a couple of sketches for a five-pointed star which may meet the wants of "C. V. F.," Knightstown, Ind. Referring to Fig. 1, draw the two diameters A C and B D at right angles to each other. Bisect one of the radii, as *o* B, at I. Now with I as center and I A as radius describe an arc, A J, cutting D *o* at J. With A as center and A J as radius describe an arc, cutting the circumference at H. Draw the chord A H, and it will form one side of the pentagon. Finish the pentagon by spacing around the circumference, and then draw the lines A F, H E, E G and G A, completing the star. As the applicant, however, demands a way to perform this feat with the steel square, we will consider the operation in connection with Fig. 2. Here draw the diameter A C and then the line A B, and by reversing the square draw A D. Next draw B G and D H, after which B F and D E can be drawn, completing the figure by connecting F with E. I might say that the angles are all obtained by using the 7.21 on the square."

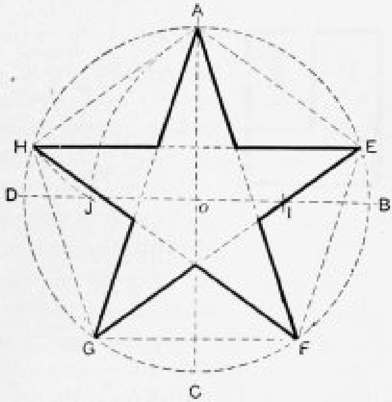
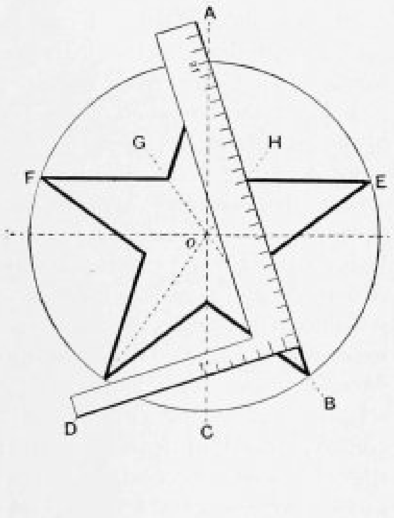


Fig. 1.—One Method of Making the Star.



STRUCTURAL.

Structural Design.

BY E. FIANDER ETCHELLS.

I AM asked to write a short article on the design of steel structures, and the trend of modern structural design. A short article must necessarily be sketchy and fragmentary, for to deal with the subject at all completely, a monopoly of the pages of this magazine would be required for the next twelve months. I might as well be asked to compress the whole art of structural design into a sixpenny telegram as to compress it into one short article. I can, however, give the pith in less than twelve words: (1) Learn from the artisan. (2) Use your common sense. (3) Study mathematics. Now let me be more definite. I say, learn from the artisan, because this appears to me to be the natural way, and it will prevent the student from designing structures and details which are impossible of execution or unnecessarily expensive. As an instance of this, I have seen steel stanchions with gusset-plate cut to the curve of a true ellipse, instead of leaving a straight edge. These unnecessarily expensive gussets were not for a theatre or restaurant, but were under some coal-bunkers. I say, use your common sense, as this will prevent students crowding two ¾-in. rivets into a 2½-in. bar, or showing rolled steel joists on the drawing which cannot be found in any maker's list. I have seen both these things done, not by students, but by alleged professional men. In fact, I was once informed that a rolled steel cantilever, unknown to any maker's list, but proposed to be used for a projecting street sign, "would be specially rolled." I say, study mathematics, because it will ultimately save you, or your employers, hundreds of pounds in economizing material by the right proportioning of parts, and will enable you to cut your materials to finer limits than if you had only vague notions of the possible forces on each bar or member. In the old days, men ensured safety by putting in extra material, and being very lavish when in doubt. Now that competition is so keen, and contracts are frequently let on the lowest tender, economy of design is very essential. Thousands of pounds are wasted annually through badly-proportioned structures. At this moment I have in view a football stand, to shelter a definite number of people, which was ordered on the express condition that it was not to cost above a stated amount. The makers complained afterwards that they had lost on the work. Now an analytical investigation of the strengths of the various parts showed than an equally strong structure could have been produced at seventy-five per cent. of the cost, and doubtless twenty-five per cent. profit would have been very acceptable. Another case in point is the following: Suppose several firms are invited to tender for storage tanks of definite capacity. All other things being equal, that firm will get the order whose tanks have the largest capacity per square foot of plate area. This proportioning is a problem in the higher mathematics, and students should at least be familiar with the results, even though they may not follow every detail employed in the calculations.

In studying mathematics, however, I would suggest that engineering students take up some course of practical mathematics, for there are some branches of pure mathematics of very, very remote assistance in practical work, and other branches of vital importance. Statics, and graphic algebra or co-ordinate geometry, are very essential to the structural engineer. A training in very elementary algebra will be necessary, so that we may use the essential engineering formulæ with confidence and celerity, and so that we may verify the formula. Be sure that every formula you use is applicable to the case. I have known students use obsolete formulæ for iron beams when they are dealing with modern rolled steel joists. I have known persons use the orthodox formula for a rolled steel joist, when that joist was not loaded in the orthodox manner, with the result that their calculations were out by about 50 per cent.

Be sure that every formula you use is correctly printed. Remember that the compositors are not necessarily mathematicians, and also that mathematicians are not necessarily good penman, and that mistakes do occur.

It is advisable to analyze every formula you can, and try and check it from first principles. This will give you a very good idea of the assumptions which are made, and will prove good and useful mathematical training. Remember that in nearly all our calculations we assume an ideal case, and the truth of our calculations will largely depend on how near the real case approaches the ideal one we have assumed. For instance, in measuring the length of a straight bar we assume perfect and absolute straightness, a condition unrealizable in ordinary practice.

It is absolutely necessary for students to study mathematics, so that they can make the calculations for any partially unprecedented case. A man may be on safe ground when he has formulæ for the problem in front of him, and a stress diagram for a similar case to fall back upon, but suppose he is asked to design an entirely new structure, say a new type of theatre girder; of what use are his inapplicable diagram and irrelevant formulæ? Again, mathematics becomes necessary, or you are likely to be deceived by the alluring advertisements of somebody's patent steel stanchions or somebody's indestructible featherweight trough decking. In the advertiser's hands the laws of nature and the axioms of mathematics become very pliable. Again, without a little elementary algebra the tabulated strength of materials given in makers' lists will be very confusing. With a few outstanding exceptions, such lists are not to be relied upon.

I append a table showing the comparison of the maximum safe loads from various section books for a rolled steel joist.

Comparison of Tabulated Safe Loads from Various List.

The section chosen for comparison is 10" x 6" rolled steel joist, span 10 feet. All figures are for distributed stationary loads.

Section Book.	Weight of Joist per foot.	Maximum safe load in tons.	Maximum stress on extreme fibres.	Nature of end conditions.	Ultimate statical tensile strength of steel.
	lbs.		Tons p.sq.in		Tons per sq. in.
A	39	18·	7·5	?	28 to 32
B	45	18·4	6·4	free	28 to 32
C	42	19·7	7·0	"	28 to 32
D	42	21	7·5	"	28 to 32
E	45	23	8	"	28 to 32
F	42	25	10	"	28 to 32
G	42	25	?	?	?
H	42	26	?	fixed	?
I	42	26·2	?	"	?
J	42	28·6	?	free	28 to 32
K	45	30	?	"	28 to 32
L	45	30·7	10	"	28 to 32

It will be noticed that, according to the list, the maximum safe uniformly distributed load on a 10-in. × 6-in. rolled steel joist for a span of 10 ft. varies between eighteen and thirty-one tons, *i. e.*, a difference of 70 per cent. between the lowest and the highest. The variety in these results does not arise solely through the quality of steel used, but chiefly from the factor of safety employed, and the different assumptions as to the fixity or freedom of the ends. Unfortunately, some of the lists do not give these essential details, or they are given in small print and demand laborious searching after, yet thousands put their whole trust in these lists with a faith that is amazing in this sceptical age. At this juncture I would impress upon all students, architects and draftsmen the necessity of giving the weight of a joist as well as its depth and width. For instance, 10 in. × 6 in. rolled steel joist leaves us in doubt whether a 39-lb. or 45-lb. joist is intended, and we are consequently ignorant of the strength of the joist intended. The same thing applies to steel angles and tees. It is not sufficient to say a 3-in. × 3-in. It is necessary to give the thickness as well. Is ¼ in. thick intended, or ¾ in.? This may seem a trifling matter, but I assure my readers that on architect's drawings this third dimension is frequently most noticeable by its absence. Such omission is as bad as ordering a pot of paint and not specifying the color.

If you are to be successful as structural engineers it will be necessary to keep notes of all the standard details you can, and to gather trustworthy formulæ for the most frequently occurring problems. As an instance of standard practice, I give a copy of some fragmentary notes I have found useful in settling the details of bases of rolled steel stanchions for small sheds.

STOCK SIZES OF ROLLED STEEL STANCHION BASE FOR SMALL SHEDS.

Outside dimension	Base Plate	Size of angles	Rivets
Inches	Inches	Inches	Inch
6x3	12x8x½	3 x 3 x ⅜	¾ diameter
6x5	12x10x½	3 x 3 x ⅜	¾ "
7x3¾	12x10x½	3 x 3 x ⅜	¾ "
8x4	12x10x½	3 x 3 x ⅜	¾ "
8x5	15x12x½	3½ x 3½ x ⅜	¾ "
10x4½	15x12x½	4 x 4 x ½	⅞ "
10x5	15x12x½	4 x 4 x ½	⅞ "

As an instance of frequently occuring formula, I give the useful formula for normal wind pressure against inclined surfaces, together with a note or two on its simplification.

$$P_n = P \sin a^{1.84 \cos a - 1} \text{ (Unwin)}$$

where P = pressure of wind per unit area on a surface at right angles to the direction of the wind.

a = angle of inclination of the direction of wind to a second surface.

P_n = normal pressure of wind per unit area on this second surface.

Unwin states "that the usual direction of the wind is probably horizontal, though it is quite possible that this direction may occasionally make a considerable angle with the horizontal, becoming, for example, normal to a roof of high pitch."

In practice, the pitch of roofs usually lies between 10 degrees for lean-to roofs and 60 degrees for Gothic roofs. Between these limits the normal wind pressure can be found from the following simpler formula, which gives practically the same result as Unwin's.

$$P_n = P \sin B \times \sin B$$
$$= P \sin^2 B$$
$$\text{where } B = 1 \cdot 2a + 18^\circ$$

For roofs higher than 60 degrees, the maximum horizontal wind pressure should be taken in preference to either formula.

In this matter of wind pressure, there are two other notes of outstanding importance. First, in an open lean-to shed with a flat roof, the wind may strike the face of the main building and beat downwards with great force, and destroy the flat roof; or, on the other hand, a wind pocket may be formed by the lean-to shed, and the wind, finding no escape, will lift the roof, so that our calculations of the horizontal component of the wind pressure on inclined surfaces becomes useless, as they do not apply to the case in hand. In dealing with flat roofs of this description, it becomes necessary to securely bolt them down, and to design them to safely stand a vertical downward pressure of at least 40 lbs. per square foot of ground plan, or an upward pressure from the under side of 20 to 30 lbs. per square foot, according to circumstances. In the case of downward pressures, this 40 lbs. includes the weight of the roof; and in the case of the 20 to 30 lbs. upward pressure the weight of the roof must be deducted to get the net upward pressure. These heavy pressures for flat roofs are justified by the experiments of Mr. Irminger, given in *The Gas World*, 6th May, 1899, and in greater detail by Mr. Nielsen in *Engineering*, on the 9th October, 1903. Mr. Irminger, however, takes up the subject from an entirely different standpoint. Secondly, it is also essential to remember that Hutton's experiments, on which the two formulæ given in this paper are based, were made on inclined surfaces with free escape of air on every side. Professor Kernot, of Melbourne University, has constructed a blowing machine, giving a fairly steady jet of air about 1 square foot in cross sectional area. To this jet he exposed numerous models of buildings, and measured the wind pressure on the various surfaces. He found the only cases in which the ordinary methods of calculations for wind pressure on roofs agree with practice are: 1st. A roof on columns with free air space underneath. 2nd. A roof lying on the ground without raised supports.

In the case of a roof supported on walls as far as the eaves, no pressure whatever was experienced on the roof.

In the case of a roof on walls, having parapets above the eaves, there was actually a negative pressure, producing a decided tendency to lift (*vide* Lineham's "Mechanical Engineering" and the "Transactions of the Australasian Association for the Advancement of Science," Vols. V. and VI.).

I give these notes here, as they are rather too recent to have found their way into the generality of text-books.

In dealing with corrugated roofs, it must also be borne in mind that there is greater necessity for longitudinal wind bracing, as the wind will catch the sides of the corries, and produce a racking tendency. If this is not taken up by wind bracing, it will be taken up by the sheets themselves, with the result that the hook bolts may work loose in the holes in the sheets. In designing open sheds for wharves, etc., it is often desirable to use angles and tees even for the tension members, so that the roof will not fail even if the wind does get under it. If the shed is open on all sides, this is not so necessary as when it is closed on three sides with the fourth side open to the river or dock.

Let us, however, turn from particular designs to designs in general. There is one general aspect of structural engineering which would considerably assist our progress in all its branches.

It is to realize, and to realize fully, that no matter what structure we take up, it is to be considered as a particular instance of the doctrine of evolution. Any given structure is as much the product of evolution as any particular animal is the product of evolution in the organic world. There is a continuous chain of progression between the first stepping stones thrown across a rivulet and the great spans of the Forth Bridge. There is an unbroken connection between the lake dwellings of pre-historic Europe and the ferro-concrete residence of M. Hennebique, of Paris. Some of the recent stages in this evolution are very clearly seen. Take first the wooden roof with the parts tied together by thongs or cord, as seen to-day in the South Sea Islands. At a considerably later stage of development, we see wooden roofs with iron nails or bolts through the joints. Next we meet with composite roofs, with wooden struts and rafters, and iron tie-rods.

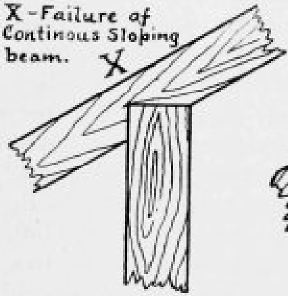


Fig. 1.

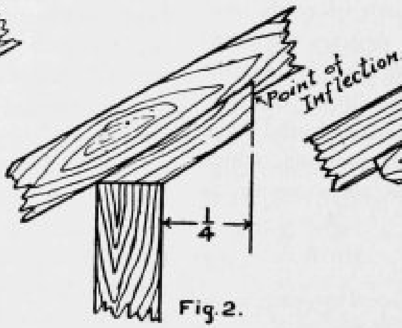


Fig. 2.

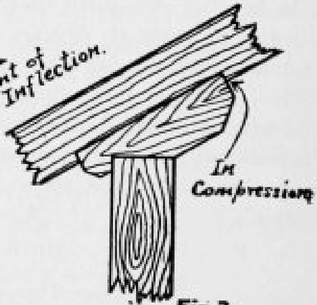


Fig. 3.

After this we find all-iron roofs. Later the iron is replaced by steel roofs and corrugated iron sheeting.

Take next the case of floors with wooden floor joists and wooden flooring. This differentiation of function betokens considerable previous development. These wooden floor joists are later replaced by steel joists with concrete filled in between. At a later stage we meet with steel floor joists completely imbedded in concrete. This leads to the use of floors of concrete with diminutive joists running through. The most recent stage of this tendency is seen in the distribution of steel into numerous round bars of small diameter running through the tension side of the concrete, as exemplified in the case of the Hennebique constructions.

Fig. 4.

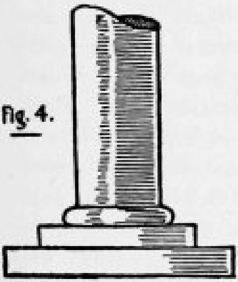


Fig. 5.

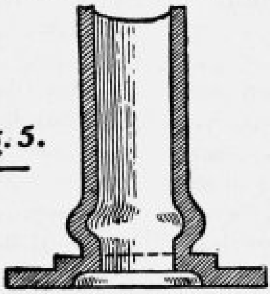
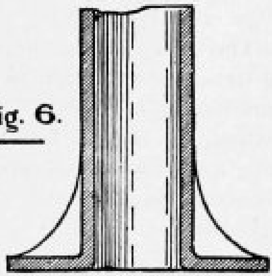


Fig. 6.



The advantage of this comprehentive view of the subject is, that the student feels greater confidence in himself when he realizes that any particular type of structure is only one link in a great chain, instead of each type of structure being "a special creation" with a special set of rules, formulæ, and diagrams. In this great, slow march of evolution, experience and theory each take their due part. Neither theory nor practice is predominant, but they are each complementary. Improvements in design are forced upon our attention largely by accidents and disasters which have occurred in the past, and theorising as to how they may be prevented in the future. That is, our structural successes are amendments on the structural failures of the past, and we to-day are making mistakes which those who come after us will have to rectify. During November, 1903, some railway arches collapsed between Cheltenham and Honeybourne, on the Great Western Railway, during process of construction. An enquiry will be held as to the cause. These arches will be compared with other arches which have stood the test of time, the materials will be examined, suggestions as to the cause of failure will be put forward, and various theories will be tried and tested; till, by a process of elimination, we find the true cause or causes of failure. The knowledge gained will thus be of use to us in designing and erecting the new arches or foundations. It is by such a process as this, though not necessarily so speedy, that each modern building or structure has evolved, and if we would desire a comprehensive view of the wide domain of structural engineering, we must look at every structure from the standpoint of evolution. I would, however, clearly impress upon you that I do not for a moment assert that every structure is an advance on its structural predecessor. Evolution includes such phases as arrested development, atavism, atrophy, and successive cycles of evolution. I have seen modern structures which would throw discredit on a builder of a mud cabin. I have seen the central pier of three piers made weaker than the end ones, although it took the greatest load. The failure of a football stand recently was due largely to "bird-mouthing" the raking beams at one of the points of maximum bending movement. (See Fig. 1). Alternative methods allow us to get the bearing surface without materially affecting the transverse strength of the beam, as shown in Figs. 2 and 3.

There is another important point in structural evolution to which attention should be drawn. It is the persistence of certain forms and details long after the use or necessity of that form has passed away. This persistence of early forms is most clearly seen in much of our modern ornaments, as these forms frequently served some real and useful purpose in the past. Let us take the case of a column. (See Figs. 4 and 5.) Here the contour is rational when executed in wood, or blocks of stone, but when this form is used for cast iron column it becomes meaningless, and even a source of weakness. A more suitable form for a cast iron column base is given in Fig. 6. Among other "vestiges of earlier forms" must be classed the meaningless spandrels or ornamental brackets under the rolled steel cantilevers of the iron and glass shelters outside hotels and theatres. In the days of wooden hoods or cast iron cantilevers, they served a useful purpose, but under a rolled steel joist they are almost invariably superfluous and very frequently a public nuisance.

It is also an essential principle of good design that every structure should be the "fittest" for the work it has to do. Herein lies the beauty of the bridge over the River Nervion, shown at the beginning of this article. Here will be found the horizontal beams forming the roadway, the vertical pillars in the spandrels, carrying the load from the flooring down to the arch itself; and the arch poised between pier and bank in such a curve that we seem almost to visualise the line of resistance sweeping through the arch's centre-line. We see also the sloping abutments, and the piers spread out to distribute the loads over the requisite foundation area. There is in every point such adaptability of form to function as must needs command approval. I believe it was John Strain, Member of the Council of the Institution of Civil Engineers, who first introduced concrete arches, but we have in this ferro-concrete arch across the Nervion what is doubtless the latest production of the structural engineering world. It is for the students of to-day to declare, in their maturity, whether this type of construction will hold its own in the commercial struggle for existence.—*"Technics."*

Think all you speak, but speak not all you think.

Let ambition be the foundation on which built the monument of success.

PATENT DRAFTING.

Patent Office Practice.

BY C. W. H. BROWNE,

of the National Correspondence Institute.

THE reproduction of drawings by means of the photolithographic process is simple, but at the same time it is particular work, for if not properly started it would give poor results no matter how well the last part of the work is done.

The first thing that is required for this purpose is that the drawing should be made clean and clear, all surface shading, either of convex, concave, or flat surfaces should be open, but the lines need not necessarily be far apart; each line should be clean cut, no ragged edges, and the lines should be distinct from each other.

If you have a first-class drawing the process is as follows:

First, a negative is taken by the wet plate process (this process is considered the best for this purpose). The reproduction should be a little smaller than the original, as it gives better results, for in reducing, many of the small defects in the drawing, such as a little roughness of lines, will be benefited.

Second, after the negative is properly developed and dried, a print is taken on a particularly sensitized paper, the background is a bright yellow, while the printed lines are a light brown. The peculiarity of this paper is that lithographic ink will not adhere to the yellow background, but will to the brown lines.

Third, a lithographic stone is placed on a transfer press and is inked all over, as evenly as possible with lithographic ink. The print is then placed face down upon the inked stone, with the top of the drawing facing the back of the press. The stone is then run through the press under pressure; the pressure is removed and the stone returned to its first position; the print is carefully lifted off and should be perfectly black all over. Now, if there were any uneven places in the face of the stone, some parts of the print would not have as much ink as others, so, as a safeguard, the print is again placed on the stone face down, but the top of the drawing is placed in the opposite direction. It is again run through the press. Running the print through the press twice in this way will reduce to a minimum any unevenness of inking.

Fourth, the print being covered entirely over with lithographic ink, it is laid flat on a smooth, hard surface (glass is generally used), face up. A wet sponge is used to wash off all the ink, and, as has been previously stated, the ink will not adhere to the yellow background, but only the brown lines showing the drawing. We now have a print that is a reproduction of the drawing with the lines shown in ink. This print is dried and afterwards is given to the transferrer to transfer to the stone. The transferrer places the dry print face down on a lithographic stone, places a layer of paper over the print and drops an iron frame which holds a piece of zinc on the stone. The stone and iron frame with the zinc is then run through the press under great pressure, which is a squeezing pressure. The pressure is taken off and the stone brought back to its original position, the iron frame lifted up, and the layer of paper removed. It is then found that the print has adhered to the stone. The back of the print is thoroughly wetted so that the print can easily be removed. Sometimes only a part of the print will come off; if so, it has to be wetted again. Great care must be used in taking the print off. After it has all been removed it will be found that the ink that was on the print has been left on the stone. These slight ridges of ink on the stone are the base for adding more ink. The stone is again wetted with the sponge, and an ink roller is passed over it. As the ink is greasy and the stone is wet, the ink will only adhere to the ink lines that were previously pressed on the stone. The transferrer now looks at the transfer on the stone, and cleans off with a sharp steel tool any spot or foreign substance that does not belong there. When this is done he washes the stone over with a weak solution of nitric acid, which cuts the stone down between the ink lines. Of course it is only a very small fractional part of an inch, but it is enough for the purpose if the lines of ink are slightly raised. The stone is now ready to go to the steam lithographic press where the desired number of copies are printed, but in printing, the stone is always kept wet, so that as it passes under the ink will only adhere to the ink lines.—*"Spare Time Study."*

Telephone wires are often rented for simultaneous telegraph use, by companies operating long distance systems, for as much as $20 a mile, annually, for twelve hours' service daily. The telegraphing goes on at the same time with the regular telephone use of the wires. The United States Telephone Company, which has a system centered in Cleveland, rents thousands of miles of wires for simultaneous telegraph use. Its customers are mainly brokers and other business houses.

Near Crefeld, Germany, many looms are run in the homes of weavers by electric motors of one-fourth to one-half horse-power, the current being supplied from a central station, where the power is generated on a large scale, at the minimum cost and with the most approved machinery. In many parts of Europe, it is believed, there will be a great extension and revival of home industries by the aid of power obtained in this manner from great distributing stations, where it can be produced at small cost and controlled by experts.

HOME STUDY.

Elementary Course in Mechanical Drawing

(Continued from May Issue.)

Working Drawings, and Tracings.

CHAPTER VI.

The first thing to be considered when about to make a working drawing of an object is how much must it be reduced to go on the sheet.

If small enough to be represented full size in two or three views, so much the better but when too large for that, a suitable *scale* must be selected that will give a drawing as large as possible to which the *full size* dimensions should be attached.

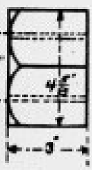


Fig. 1

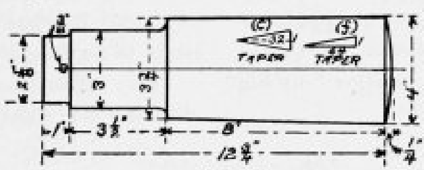


Fig. 2.

Fig. 3.

A good working drawing must not only be drawn to a scale but it should be fully dimensioned, for if it is not dimensioned, the workman must get his sizes from the drawing by applying his rule or a suitable scale, an operation which takes time and is very liable to result in error.

Some draftsmen place the figures for the dimensions so that they are all read one way, as in Fig. 1. Others again prefer the figures at right angles to the dimension lines as shown in Fig. 2. In marking the distance between two lines, be careful to put the arrow-points up to the lines as shown at (a) Fig. 3 and not as shown at (b). The arrow-points should also be put on the inside as shown at (a) and not outside as shown at (c) unless the lines are very close together, as shown at (d).

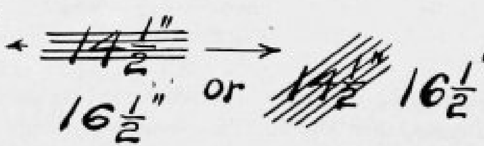
All dimensions which a workman may require should be put on the drawing so that no measurement of the drawing or any calculation need be made. It is not enough to give the lengths 1 in., 3½ in., 8 in. and ¼ in. of the different parts of the object in Fig. 2, but the length over all 12¾ in., which is the sum of all these lengths should also be marked. Fractions should be made with a horizontal line between the figures, never with an oblique line.

Where a hole is to be shown, the diameter is marked as in Fig. 2. It is assumed that it is a round hole and that it will take a drill of that size. If the hole is to be threaded, mark it the size of tap required, that is, if we write "⅜ in. tap," it will need a drill smaller than ⅜ in. and when finished with the tap, it will then receive a ⅜ in. screw.

Sometimes when the drawing is sent to the shop it is found that parts do not fit well or are out of size so that a change in some dimension is necessary, the old one is often erased and a new one inserted without any record being made for future reference.

Such drawings should be marked "revised" and by adding a note near the figure altered, much time is often saved in the pattern shop if the pattern is to be changed too.

Suppose that on a drawing the dimension read 14½ in. and it was changed to 16½ in., it would be better to write 14½ in. alt. to 16½ in or to scratch out the 14½ in. and write in the new, either below or to one side of the old figure as shown in Fig. 4.



Then the old and new dimensions can be seen at a glance.

The dimension lines should be thin lines, either black or colored, but the arrow-points and figures look best in black and should be made with a common writing pen, and this part of the drawing should be as neat as possible. Many a good drawing is spoiled by poor lettering and figuring.

The amount of taper on an object may be indicated by drawing a triangle as shown at (e) Fig 2 or at (f).

The triangle at (e) shows a taper of 1 in 32 *on the diameter*, that is, the diameter varies at the rate of 1 in. in 32 in. or ¼ in. in 8 in.

The triangle (f) shows a taper of 1 in 64 *on the radius*, that is the radius varies at the rate of 1 in. in 64 in., or ¼ in. in 16 in.

In getting up the drawings for a complicated machine, the best way is first, to determine the chief dimensions, then make a general drawing of the whole, leaving out some of the smaller details.

Then make working drawings of all the parts or details as they are often called, taking the larger and most important ones first. Lastly, finish up the different views of the complete machine so to see that all parts fit in properly.

The appearance of the general drawing is sometimes improved by surface and line shading as described in a previous chapter, and in the detail drawing such section lining and notes should be put on as needed.

TRACINGS.

Tracings are copies of working drawings on some transparent material, usually paper or cloth.

If a piece of tracing paper or cloth is placed over a drawing, the lines can be seen through it and can be reproduced thereon, this is usually done in black ink.

Tracings are often made from a pencil drawing and finished up much more completely than the drawing which is then laid away for reference or destroyed.

Nowadays, the tracing is seldom sent to the shops but a photographic production of it called a "blue-print" is used for all work outside the office. These are on paper with blue background and white lines and figures.

The process then is, first to make a drawing, then a tracing in good jet black ink, finishing it thoroughly as to dimensions, sections, etc., check it up to see that all parts are correct, make a blue print and send it to the shop, keeping the tracing for future reference.

Before the introduction of blue-prints, drawings were nicely finished and even colored and sent to the shops, but if lost, there was no record of the work.

Sometimes the tracing is sent out on the work and the original drawing kept in the office but this is a poor practice.

Tracing cloth has its two surfaces finished differently, one glazed and the other dull and the opinion of draftsmen differ as to which side should be used.

Some claim that it is easier to work on the glazed side, that erasures can be made better on that than the dull side.

In using either side, it is found that the cloth when fresh treats the ink as if the surface was oily so that the common practice is to rub the surface to be used with a prepared chalk or other like substance.

In this course, it is suggested that the dull side be used and if erasures are to be made, they should be made with a very sharp knife or ink eraser, then rub the place with a piece of soap stone. This produces a surface nearly as good as the original and will usually take ink well.

To be continued.

ILLUSTRATING.

Show Cards.

TO the show card writer who does his work in more or less haste, from necessity, I think there is nothing handier than the compound curve. I mean the line that curves one way for half its length, and the other way the other half. It can be "laid out" without a ruler, and is best and most graceful when formed by a free sweep of the arm. It is easier to make than a plain curve, and permits very convenient latitude in the arrangement and spacing of the wording.

As shown by the specimens herewith, the display line laid out in a compound curve may be used in many ways—two of them on one card, one in the center with catch words above and below it, and one taking up more than half the card and leaving a good place for the price figures.

The compound curve is useful not only in making window cards, but on bulletins and posters. It greatly relieves the harshness of straight lines, and reduces the work of laying out the job to the minimum.

Take the umbrella card shown here. The "artist" begins at the first "S" and

simply works along until he gets to the end of the word—it doesn't matter whether or not they fill all the space on the line. Then he begins at the "!" on the lower line and works backward—at least I do—and that word is bound to come out right, with out any pointing off of space for each letter.

Now, when you determine to display a line in a curve, you've got a lot more trouble on hand; just try it and see. And the compound curve is much more pleasing to the eye, anyway. I used to make a good piece of money

with a lettering pencil, and I always regarded the compound curve as my most helpful resource. D'AUBER.

—*The Advertising World.*

Questions and Answers.

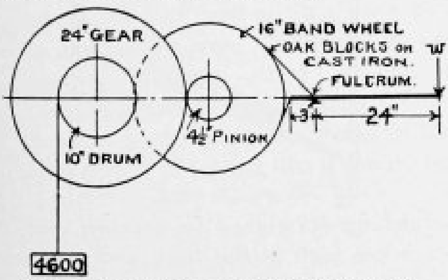
What weight will it require on the brake lever to sustain a load of 4600 pounds at w?

Give formula and solution if posible

A. In the first place; the weight must hang from the opposite side of the drum to that shown if the lever is so arranged as in the sketch.

$$\text{Then} \times \frac{10}{24} \times \frac{4.5}{16} = 539 \text{ lb.} =$$

Force required at circumference brake wheel to keep load from running down. Efficiency of machine being 100 per cent. The loss in efficiency will help to keep the load from falling.



Let 95 per cent = Approximate efficiency between load and drum gear teeth 96 per cent = approximate efficiency between drum gear and brake wheel. $P = 539 \times .95 \times .96 = 492$ lbs. To be held at rim of brake wheel.

Say the brake band is arranged to grip ¾ or 270° of the brake wheel.

$$\text{Log } N = \frac{T}{t} = 2.7288 \times f \times C$$

$$\text{Log } N = 2.7288 \times .2 \times .27 = 40932$$

$N = 2.566$ (See Kent, Rankine, Unwin, or any work on Mechanics.)

T = Pull in tight end band,

t = Pull in loose end band,

f = Coef. Fric. = .2 to .25 OaM on C. I.

$$C = \frac{270}{360} = .75$$

$$T = P\frac{N}{N\text{-}I} = 492 \times \frac{2.566}{2.566\text{-}1} = 806 \text{ lbs. on}$$

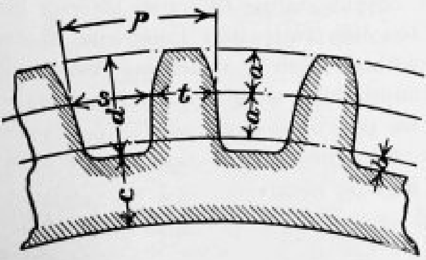
Tight End.

$$T = P\frac{I}{N\text{-}I} = 492 + \frac{I}{2.566\text{-}I} = 314 \text{ lbs. on}$$

Loose End.

$$W = \frac{314 \times 3}{24} = 3.92 \text{ lbs. Ans.}$$

Q. What are the proportions of gear teeth?



A. The following table gives proportions suggested by the different authors of mechanical text books.

p=circular pitch.

	Kent	Reid	Grant	Unwin	Rankin
t	.475p	.48p	.46p	.48p	.47p
s	.425p	.52p	.54p	.52p	.53p
a	.3p	.3p	.34p	.3p	.345p—.02
b	.1p	.05-1	.04p	.05p	.06p+.04
c	.7p	.48p		.48p	
Face	2 to 3p	2.5p		2 to 3p	

CURRENT TOPICS.

In the Drafting Room.

The whistle blows a long, shrill blast
at seven in the morn,
Two draftsmen appear, but the last is
late on account of his corn.

They talk about their girls and the fun
they had last night,
While cigarette smoke about them
curls they sing with all their
might.

But hark a sound of footsteps is heard
to approach the door
Then everyone with a nimble bound
his board is leaning o'er.

A familiar face has entered, 'tis the
assistant superintend'.
All eyes on him are centered, silent
oaths at him they send.

But he cannot stay there always for
'tis a glorious day
And helloh! Here comes Charley to
while an hour away.

The morning sun mounts higher, 'tis
nearly nine o'clock.
What was that you said sir, be careful,
don't you knock.

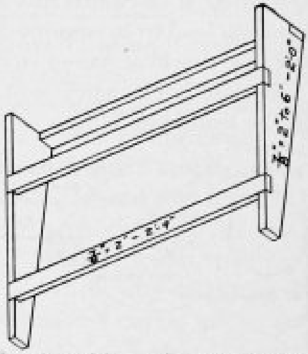
Our work is rather brain racking and
eight hours is enough,
If we're compelled to come at seven
two hours must be bluff.

To the Editor of "The Draftsman."

Sir:

There have been several references in recent numbers of "The Draftsman" to various methods of supporting a drawing board in a slanting position upon a flat top table and I am sending herewith a sketch of a still different one thinking that it might be interesting to draftsmen generally.

This stand, as shown by the sketch, consists of a light pine framework



about 2 ft. wide, 2 ft. 9 inches long, 2 inches high at the front and 6 inches high at the back. These dimensions give a convenient size to accommodate a 27 x 39 drawing board, and a slant about as steep as possible with scales and triangles sliding off.

By arranging the cross pieces a little differently and lining the frame with oil cloth or something else strong and light in weight, a handy receptacle for papers, books, and the like can be made, the drawing board itself forming the cover.

W.

Draftsman's Visit to New York.

I well remember one beautiful Monday morning in the early summer time. I had been to the Bronx Zoo on Sunday afternoon and to Coney that night, with a bunch of those good fellows, a mixture of Elks and Eagles, I believe. Well, on this ne'er to be forgotten day, I paid a visit to a large *plant*, it was in full foliage and among the branches disported several long-legged aquatic birds of the *crane* variety. I asked why they were not down wading in the water, but was told they were *electric cranes.*

The first thing that struck my fancy in the machine shop was a *dog* in a lathe turning around at a two-forty clip. I asked the operator what sort of a dog he was. He said it was a revolutionary dog, and although so old could stand a pretty good *feed*, but when the feed was on it always had its tail in the *plate*. The way it was *chasing* a large screw around, I thought it had its tail in its face. When it stopped one could see it was in the *face-plate*. It looked like a setter, for it certainly was set on the work.

I kept an eye on a large *spider* for fear he was dangerous, but didn't see a *crab* coming down the line with a load of *fish-plates* until I got pinched by him between a *pair of horses* and a large *bull-ring*. There was several tons of *pig* on that pair of horses, they were heavily built, and as there was no *scrap* in the bull-ring I ducked that way. Just then one of those blame cranes flew up from the wharf and dropped a *clam-shell* right over me. It certainly closed up like a clam and started off with me. Now I never did like clam soup but seemed to be in it just the same. I was thankful to have gotten away from the bull-ring, but when that shell opened I landed right on a *bull-riveter*. Now, just because I dropped from a clam-shell didn't say I was bullion, but I nearly got in the dies just the same.

There was an awful noise out there and Miss *Dolly Barr* was trying to hold an animated conversation with a pneumatic riveter. He struck her fancy so hard and fast that she said he was too warm a proposition for her and not being a *holder-on* dropped it. I saw a *monkey wrench* a nut around, but it must have been too hard a nut for him to crack as he bolted, slipped off and fell to the floor.

There were several *old men* drilling up and down the shop. I addressed one but he said he wasn't stationary, they had to bolt him to work; he was stamped just the same. I asked him what his favorite drill was, but just then a ram butted in and interrupted the conversation. It seems this ram was part of a slotting machine. I asked if it was a nickel machine and was informed that nickel was in the steel. Asking if it was tempered proved very foolish, for the wind it knocked out of me certainly was not tempered to a shorn lamb.

I was curious to know what was in a tank and was told it was one of Heinz's 57 varieties. They would not let me try it, however, as they didn't pickle things when they were done. I felt pretty well done and took an L for home but they turned the Y on me. That sobered me up. I returned my pass at the office and got out.

A BUGHOUSE.

GENIUS.

"Genius, that Power which dazzles mortal eyes,
Is oft but Perseverance in disguise;
Continuous effort, of itself, implies,
In spite of countless falls, the power to rise.

"'Twixt failure and success, the point's so fine,
Men sometimes know not when they touch the line,
Just when the pearl was waiting one more plunge,
How many a struggler has thrown up the sponge.

"As the tide goes clear out, it comes clear in;
In business, 'tis at turns the wisest win.
And oh, how true when shades of doubt dismay;
'Tis often darkest just before the day.

"A little more persistence, courage, vim,
Success will dawn o'er fortune's cloudy rim,
Then take this honey for the bitterest cup—
There is no failure save in giving up.

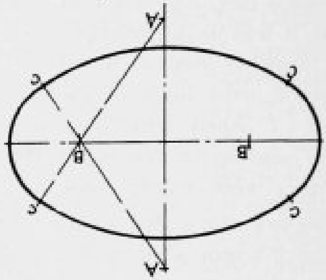
"No real fall as long as one still tries,
For seeming setbacks make the strong man wise.
There's no defeat, in truth, save from within;
Cnless you're beaten there, you're bound to win.

HENRY AUSTEN.

The National Messenger.

MEETING POINT OF CURVES.

When two curves are drawn in on a drawing, they should be joined neatly, and to do this each should stop at a certain point. Suppose as in the figure, the centers of the arcs of circles used are at A & B. To help the work where part could be inked in, the



arcs about B could be drawn in pencil and pencil lines drawn from A through B, cutting the arcs, say at C. These will be the ends of the arcs, so that the ink arcs about A as a center may then be drawn to C.

EASY LESSONS IN ARCHITECTURE.

This little work is compiled with the view of creating a taste in the mind of the young for the noblest of the arts—architecture.

Beginning with the early history of architecture, it traces the styles through to modern types, and it is done in an easy and careful manner.

Nearly every page contains an illustration and which are referred to in the text, which is entirely free from mathematics.

This book is published by The Industrial Publication Co., 16 Thomas St., New York, N. Y., and is sent postpaid for fifty cents.

Some Directions to Students used at Kalamazoo Manual Training School.

Whenever a drawing is to be tinted the paper must be shrunk down so that it will not wrinkle when wet and remain wrinkled after it has been finished. Place the paper on the board with face side up. Fold up about 5/8 to 1 inch of the margin on all sides so that the paper will resemble a shallow box. Turn the paper over so as to rest on the turned up edges. With a clean sponge and water dampen all of the surface of paper except the turned up edges which are to receive the paste, glue or mucilage. Then wipe off all of the water from paper and turn right side up. Rub down and stretch the top and bottom edges of paper first. Be sure and leave no wrinkles either in the edges or in the corners. The other edges are then treated in the same manner. The edges must be kept straight. If no wrinkles are left in edges or corners the paper will dry smooth. The paper muct be allowed to dry slowly; if placed in sun or heated it will get too dry and wrinkle when exposed to an ordinary temperature. To avoid streaks in paper, use clean water and sponge and wipe off all water, and have board flat when placed to dry. Be sure no water gets on the margin of paper used for paste and that no paste gets on the middle of drawing board or inside the dry edges of paper, to cause trouble in cutting off the paper when the drawing is finished. In large drawings both sides of the paper are wet but it is best not to wet the face when stretching the paper because the surface is lost and then the paper soon becomes soiled. Do not attempt to draw on paper until dry and smooth.

A drawing that is to be tinted must be made carefully with lead pencil and if possible without erasing, the surface to be tinted if rubbed or scratched will be apt to show when finished. The drawing can be tinted without inking in if all lines that are not to be inked are removed, a lead pencil line when wet becomes almost indelible and difficult to erase. If the drawing is *Inked* in first the paper must, when the ink is dry, be washed with plenty of clear water to remove any superfluous ink from paper that would cause dirty colored tints in the drawing. Do not rub paper hard with sponge or the surface of paper will be injured.

When the surfaces are to be tinted the drawing board can be slightly inclined in one direction so that the color may flow easily in one direction. The surfaces can be wet with clear water before the color is applied and more even tints will then be secured than if the color is applied at once to the hard, dry surface of the paper. The most common way is to use a double end brush, the large end to hold clear water for blending, the small end to hold the color. With considerable color in the brush but not nearly all it will hold, commence at the top of the surface to be tinted and follow it carefully with the first stroke. Before the color dries at the top, lay on the color below by moving the brush back and forth, using enough color in the brush so that it will flow gradually, with the help of the brush towards the bottom. The lines must be followed carefully at first, and the brush not used twice over same place while surface is wet or streaks will form. Do not paint the colors on, but allow them to flow quite freely after the brush.

It is best to protect the drawing with a sheet of paper and only expose the surface needed. Clean blotters are useful in many ways, a blotter with ink on it should never be used when tinting surfaces as the ink might ruin the colored surface.

Be sure your brushes are clean and never put a brush away until cleaned and with the hair drawn to a point in proper condition to dry. Tints must be mixed with clean water, kept stirred up and from dust. Try to tint a surface with one brush full of color if possible. If a heavy color is desired it is best to apply a lighter shade first and a darker afterwards.

In the color boxes will be found the *Primary Colors, Red, Yellow, Blue.* To produce the *Intermediate Colors: .Orange,* use red and yellow; *Violet,* use red and blue; *Green,* use yellow and blue. To produce *Black* use stick India ink in place of bottled ink or red, yellow and blue in equal proportions. *Brown,* use yellow, blue and most of red; *Grey* use red, yellow and most of blue; *Terra Cotta* or *Brick,* use red, yellow and less blue.

The following tints are suggested:

Cast Iron, India ink, blue and red; Wrought Iron, India ink and blue; Steel, blue; Glass, green; Brass, yellow and red; Copper, red and less yellow; Stone, India ink and blue; Brick, or Terra Cotta, red, yellow and less blue; Wood, yellow or brown; Water, blue or green; Earth, yellow, blue or brown.

Colors can be made more permanent by adding a little Gum Arabic to the water when mixing but little should be used, a little blue will help black ink and remove the greyish tint.

Summer School.

Courses in the following subjects will be given by instructors of Case School of Applied Science, Cleveland, Ohio, beginning June 21st, and continuing for six weeks:

CHEMISTRY.

General Chemistry, Qualitative Analysis, Quantitative Analysis.

MATHEMATICS.

Elementary Algebra, Plane, Solid and Spherical Geometry, Advanced Algebra, Trigonometry, Analytic Geometry, Calculus, Roofs and Bridges.

MECHANICAL ENGINEERING.

Heat and Steam, Mechanism, Machine Design, Joinery and Pattern Making, Iron Work, Machine Drawing.

PHYSICS.

Elementary Physics, General Physics, Physical Laboratory, Teachers' Course.

MODERN LANGUAGES.

Elementary German, Advanced German, Advanced French.

MINERALOGY.

APPLIED MECHANICS.

Statics and Strength of Materials, Dynamics, Hydraulics, Testing Laboratory, Descriptive Geometry and

Drawing.

These courses will be of especial value to teachers who have been called upon to take charge of instruction in elementary science and to those who intend to enter the institution in the fall but have been unable to make complete preparation, as well as to those students who, on account of illness or other cause, are deficient in their regular work.

In each course personal instruction will be given adapted to the individual needs of the students, and persons desiring courses other than those mentioned can undoubtedly make satisfactory arrangements upon application.

In order that any course may be given a minimum number of students must make application before *June 14th.*

The laboratories will be open all day and the same facilities are offered for practical study during the summer as are open to students during the school year

A brief description of the laboratories and their equipments will be found in the general catalogue

TUITION AND FEES.

For each course, excepting Elementary German, the tuition will be $25.00. For Elementary German (double course) the tuition will be $40.00.

Students in the Chemical Laboratory will be charged $5.00 for materials used and will be required to deposit $5.00 against breakage in addition to tuition.

Tuition and fees must be paid to the instructor in charge of the department, upon registration, June 21st.

Inquiries about courses should be addressed to the instructor in charge. For catalogues and information about the institution. Address,

CHARLES S. HOWE,
President.

Germany and America Compared

The following is a comparison of the German and American trains, which shows manifestly to which country belong the honors of the fastest trains:

	German.	American.
Whole number of trains averaged	321	303
Number of lines showing trains having an average running speed above forty miles per hour	22	26
Number of trains having an average journey speed above forty miles per hour	18	90
Total number of trains having an average running speed above forty miles per hour	45	122
Number of trains having an average running speed above fifty miles per hour	3	12
Number of trains having an average running speed from forty-five to fifty miles per hour..	4	36
Number of trains having an average running		

speed from forty to forty-five miles per hour	38	74
Number of groups showing when all trains of group were averaged, a journey speed above thirty miles per hour..	3	22
Number of groups showing when all trains of group were averaged, a running speed above thirty-five miles per hour	3	18

In summing up the evidence it may be said that to America belongs the fastest trains, but at the same time European trains seem to have the advantage over us on the middle distance travel, and then, again, in the long distance journey, this country appears to excel Europe.

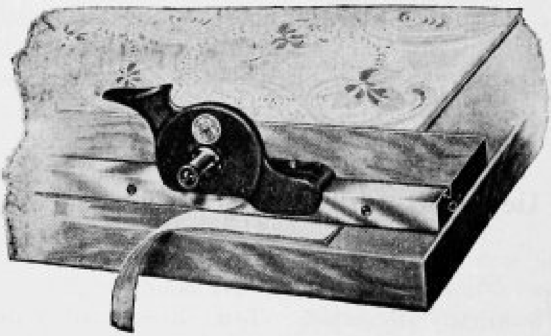
The Simplex Trimmer.

The Simplex Trimmer is designed to trim wall paper, drawings, blue prints, etc.

It is very light and durable and will cut true to the straight edge at all times.

By means of a straight edge, drawings and blue prints could be easily trimmed.

An outfit consists of a Trimmer, Straight Edge and Zinc Strip and prices may be obtained by writing Webster & Parks Tool Co., Springfield, O.



Charles S. L. Baker, a negro of St. Louis, claims to have perfected, after twenty-three years of labor, a process for generating heat and power by friction without combustion. The heat produced is used in the form of hot air, hot water, or steam, and Mr. Baker claims that the particular motive power used in creating the friction is not essential. It may be either water, wind, gasoline, or any other source of energy. The most difficult part of the inventor's assertions to credit is the statement that his system will light or heat a house at about half the cost of methods now in use. The business world will accept that claim only after complete demonstration, and scientific authorities will be equally incredulous.

Perpetual Motion Tragedy.

Aged Inventor Died Soon After His Machine was Destroyed.

If there be any one negative proposition in mechanics that is held to be undeniable by the entire scientific world, it is that it is not possible to construct a perpetual motion machine. And by a perpetual motion machine, taking it in its simplest form, is meant a piece of mechanism which will remain indefinitely in continual motion solely by the action of the attraction of gravitation.

Nevertheless, says the New York Herald, no less a person than Mr. David M. Stone, who was for many years the editor of the Journal of Commerce, and whose personal character has always been above suspicion, is the authority for the positive statement that he had in his possession for several weeks, about fifty years ago, a machine of precisely that sort. He declared that the files of the Journal of Commerce of about 1852 contained a full account of the machine, but these files were destroyed by fire, and he told the story from memory. "However," he declared, "I remember the facts perfectly.

"About 1852 an old man, perhaps eighty years old, brought the machine to my office to show me. It was constructed about like this. I think there were six of the hollow arms. In each one was a little ball. The arms were not rigidly fixed, but had a little play. As the cylinder revolved the balls rolled. Thus the balls in the arms on the right were always an inch or so further from the center than those on the left, and they counterbalanced the weight of the arms themselves. The whole machine was always, therefore, heavier on the right than on the left, and so it always revolved. I think there was also a spring in each arm that helped the reaction of the ball, but I cannot recollect the arrangement of the springs.

"Then there was a pendulum that was geared to regulate the speed. If that was disconnected the machine went faster and faster till the centrifugal force kept all the little balls at one spot, and then it would go slower and slower till it stopped. I tried that once and started it again with my finger.

"Well, I kept that machine in my office for several weeks, under my own private lock, to make sure that there was no trick about it, and it went right along. The Journal of Commerce printed an account of it, and was ridiculed unmercifully in consequence, but the machine kept right on going.

"Then the old man exhibited it at a fair in New Jersey, charging a small entrance fee, and some local scientific men—I think one of them was a Princeton professor—had him arrested for taking money under false pretenses. He was arraigned and the justice of the peace asked him what defense he had, and the old man said his only defense was that the machine did what he claimed. The justice was angry and asked him how he dared say that when these eminent gentlemen swore that there must be a spring in it or it wouldn't go.

"And the old man said: 'I have

worked at it for forty years, and there is no spring in it, and it does go.'

"So they got an ax and chopped it up, and there was a great silence, for there was no spring. And the old man picked up the fragments and went away with the tears rolling down his face. And he died soon after."

Books Reviewed.

The firm of Winn, Milmore & Porter, engineers, designers and draftsmen have moved from Unity Building to Stock Exchange Building, Chicago, Ill. They publish a chart of gauge numbers and the nearest decimal equivalents which should hang beside every draftsman's desk.

Architects and draftsmen who have specifications to prepare will appreciate the Improved Specification Blank for Masons, Carpenters, Tinners, Plumbers and Painter's work, which is prepared by Palliser & Co. and published by the Industrial Publication Co., 11 Thomas St., New York, N. Y. Price, 15 cents.

Bevel Gear Tables—a collection of tables and necessary explanation to enable anyone to figure bevel gears without the use of trigonometry.

Few people who have once used this book for obtaining the necessary data for a bevel gear will ever again resort to the slow and tedious method of figuring them.

Beginning with Tooth Elements and continuing through the construction and calculating of the bevel gear, the book is clearly illustrated and printed on coated paper, written by D. Ag. Engstrom, cloth bound, 5½ x 8 in. pages, postpaid, $1.00. The Derry Collard Co., 257 Broadway, New York.

An album of St. Louis and the World's Fair, size 10 x 15 in., with 185 illustrations, including a bird's eye view of the Fair, size 23 x 29 in., will be sent to any address on receipt of 31 cents in stamps. Geo. A. Zeller, 185 4th St., St. Louis, Mo.

This has been called the "age of illustration" and the writer of "Rogers Drawing and Design" has certainly kept this in mind, while preparing this splendid work.

The helpful value of a teacher or instructor is a blessing to a student but a well illustrated and written book will often almost suffice when the young man is determined to learn.

The work is comprised of some twelve divisions of which the first five take up the preliminary details, including working drawings, tracings and blue printing. The divisions from six to ten inclusive are devoted to Machine Design, Transmission Methods, Metal Working, Machinery, Engines and Boilers, Electrical Machines, etc., etc.

"Part Three" contains a treatise of drafting instruments and their uses and a large number of tables of value to the draftsmen and designers.

The book is beautifully finished, contains nearly 500, 8 x 10 inch pages, nearly every one of which has an illustration, cloth binding, gilt edges. Price $3.00, published by Theo. Audel & Co., 63 5th Ave., New York, N. Y.

UP IN THE WORLD.

"There is every opportunity for young men to rise in the world in this age," said Old Jilson, speaking of flying machines.

IN THE AIR.

Friend—Did you raise—

Inventor—Raise what?

Friend—Your airship scheme?

Inventor—Oh, I haven't been able to raise anything but money so far.

AN IMPRESSION.

"The Japanese are wonderfully bright people."

"Yes," answered the plodding person. "I should think they would have to be in order to spell and pronounce their own names."—Chicago-Record Herald.

THE TROUBLE.

"How often do we find that great inventors are allowed to go unrewarded and unrecognized!"

"Yes," answered Senator Sorghum, "the trouble about inventors is that they insist on inventing machinery instead of ways to make money."—Washington Star.

In China a mile is anything from a quarter of a mile to a mile and three-quarters, according to the province in which it may happen to be.

Editor Draftsman.

Your April number contains articles by both Mr. Florence W. and Mr. M. C. Hurd, who endeavor to show the error in Mr. Babbitt's construction "Something for our Geometrical Friends" in the December number. Both are wrong in saying that lines KE and CE are not equal.

Mr. Florence W. says, "The error is found in the assumption that KE equals CE." Now in the original article, no such assumption was made because line KE and CE are positively made equal by construction. He then goes on to say, draw square ABDC, bisect BD and erect a perpendicular in G. making GE equal to the distance shown in the original. The original was a geometrical sketch and not a drawing therefore it is incorrect to assume that line GE should be the same length as was shown. Point E is the intersection of the perpendicular bisectors of lines AC and KC and not where it was shown. It was a matter of convenience that it was so placed.

Plans have been filed in Chicago for an Iroquois Memorial Emergency hospital, to be erected in that city, and to provide and maintain an institution in memory of the victims of the Iroquois theater fire on Dec. 20.

Scientific authorities continue to look more to mechanical devices, heavier than the atmosphere, for progress in aerial navigation, rather than to airships sustained by gas and made, with their passengers, as light, or nearly as light, as the air they displace.

To make Iron Cheaper.

College Professor claims to have big discovery.

Madison, Wis., April 17.—Professors C. F. Burgess and Carl Hambuechin, of the college of engineering of the University of Wisconsin, have discovered a method of making pure iron at a small cost. Under the new discovery, which is the result of three years of research work, the product can be made for a fraction of a cent a pound.

The process is similar to that used in refining copper, an electric current taking the impure iron from a plate and depositing it in a pure state upon another plate. The pure iron has valuable properties not possessed by ordinary iron or steel. On account of its electrical properties, it is a valuable material for the construction of electrical apparatus, and it furnishes the means for making special steel alloys of great strength and hardness.

BOOKS, ETC.

THE DRAFTSMAN reaches fully 10,000 readers each month, so that a review of your book, catalog or other literature would be well received.

Anything you have to send will have our careful attention. Books, catalogs, photos of new machines, etc., etc., desired.

Address THE DRAFTSMAN,
Cleveland, O.
107 The Beckman Bldg.

A man turns 112,000 spadefuls of earth in digging an acre and moves in all a weight of 850 tons.

Circulars of instruments from C. W. Morey, The Temple, Chicago, Ill., show a partial list of bargains in new and second-hand instruments.

Albert Rogers, a Plainfield, N. J., inventor, claims that he will display at the St. Louis exposition an improved electrical apparatus for registering alarms at fire stations. At night the system automatically lights up the building in which it is used, a clock registers the time of the alarm, and the doors of the stables are immediately swung open.

RAPID CALCULATING.

By use of the Fractometer, calculations may be rapidly made, especially when fractions enter into the work which always do with a draftsman.

An illustration of the machine is shown on another page and is of simple construction and operation.

Directions are with each machine to aid in its operation and further information and prices can be obtained by writing The Fractometer Co., 81 Dearborn St., Chicago, Ill.

Japanese Weights and Measures.

The R. D. Nuttall Co., gear makers, Pittsburg, Pa., have issued a "Special War Edition" of their monthly data cards, on which is given much useful information concerning the weights and measures used by the Japanese, that plucky race of men who are fighting the Russians.

Tables are therein given to show the comparison with the English systems, and it will be noted that most of the values in the Japanese tables are in multiples of ten as the English

ナツトオル製歯輪
弊社製造の歯輪は普通なる鑄
製品と異り、鋼鐵塊を歯形に
截斷、滑削して製作せし者な
るが故に、鑄製の歯輪に比し
遙に堅牢、耐久なるは勿論、
二割內至四割の原動力を節減
し得る逸品なり
其他弊社は市街鐵道車用歯輪
小歯輪、軸頸并に市街鐵道車輪
附用回轉輪等を製造す
米國ペンセルヴニヤ州
ピキツバーグ市
フキエット街第九百番館
アール、デー、ナツトオル會社

should be.

The table for the money has two values for two of the pieces; evidently they were issued at different times when the values of metals had changed.

Some of the characters of the language are here shown which closely represent those of the Chinese.

It is said that there are 4,000 characters in the language which are to be modified considerably in the near future, either by making a change to some other system or dropping many of their own.

The Japanese were quite well prepared in many ways when they opened the present war, and their navy was one of the strongest.

The gun - operating mechanism in many of the largest battleships of the world's navies are equipped with Nuttall gearing, and it accuracy and durability is no small factor in the *final result*.

LONG MEASURE.

1 Mo (0.0001 Shaku) ......0.000099 feet
1 Rin (10 Mo)..............0.00099 feet
1 Bu (10 Rin)..............1.4317 lines
1 Sun (10 Bu)..............1.1931 inches
1 Shaku (10 Sun).........11.9305 inches
1 Ken (6 Shaku)..........1.9884 yards
1 Jo (10 Shaku)............3.3140 yards
1 Cho (60 Ken)..5.4226 Chains (1-15 m.)
1 Ri (36 Cho).....2.4403 miles (2½ m.)
1 Kai-Ri (Marine Ri).......1.1507 miles

DRY GOODS MEASURE.

1 Sun (0.1 Shaku) ....1.3913 inches
1 Shaku (10 Sun)........14.9130 inches
1 Tan ....(about) 11 yards
1 Hiki ....(about) 22 yards

WEIGHT.

1 Mo ....0.000008 pounds (Avoirdupois)
1 Rin (10 Mo)....................
......0.000083 pounds (Avoirdupois)
1 Fun (10 Rin) ....
.........5.7972 grains (Avoirdupois)
1 Momme (10 Fun)...............
...........2.12 drams (Avoirdupois)
1 Kin (160 Momme)..............
........1.3251 pounds (Avoirdupois)
1 Kwan (1000 Mom)..............
........8.2817 pounds (Avoirdupois)

CAPACITY

1 Shaku (10 Sai).........0.003973 gallon
1 Go (10 Shaku)..................
............1.2706 gills; 0.0199 pecks
1 Sho (10 Go).1.5881 quarts; 0.1985 pecks
1 To (10 Sho)....................
..........3.9703 gallons; 1.0951 pecks
1 Koku (10 To)...................
.......39.7033 gallons; 4.9629 bushels
1 Square Shaku ......about 1 square foot

SUPERFICIAL MEASURE.

1 Tsubo (36 Square Shaku).........
..................3.9538 square yards
1 Se (30 Tsubo)..about 119 square yards
1 Tan (10 Se)..............0.2451 acres
1 Cho (10 Tan).............2.4507 acres
1 Square Ri.........5.9552 square miles

CURRENCY.

	Value Gold $ c U. S.	£	s British	d
Sen				.5
Itzebu, new				
Yen, 100 Sen	75.3			
Yen, 100 Sen	99.72		4	1.18
Cobang, old	3.57.6		14	8.35
Cobang, new	4.44.		18	2.96
20 Yen	19.94.4	4	1	11.6

School for Artisans,

The College of Engineering of the University of Wisconsin, begins June 27th.

Courses of study are offered in the following subjects:

1. *Steam, Gas and Other Heat Engines.*—Lectures on the theory of heat, the operation and methods of testing steam, gas and air engines, boilers, compressed air and refrigeration plants.

2. *Applied Electricity.*—Theory of direct and alternating current dynamos and motors, the operation and methods of testing electrical machinery, batteries, transformers and other apparatus, phatometry and calibration of instruments.

3. *Mechanical Drawing and Machine Design.*—Elements of applied Mathematics, courses in Mechanical Drawing and Machine Design adapted to the preparation of the students.

4. *Materials of Construction, Fuels and Lubricants.*—Lectures on the properties of materials accompanied by laboratory tests; lectures on fuels and lubricants with laboratory tests on the heating value of coals and efficiency of lubricants.

5. *Shop Work.*—Practice with hand tools, wood and metal working machinery, and in blacksmithing and pattern making.

The instructional force is taken from the regular faculty of the College of Engineering, and the entire laboratory and shop equipment belonging to the College is used by the students in the Summer School.

This school offers to those unable to take a regular four years' course an opportunity of obtaining practical working knowledge of the methods of testing and the use of instruments, together with such theoretical principles in each case as the nature of the subject and preparation of the student may permit.

A bulletin describing the work of the School for Artisans in detail will be sent on application to

FREDERICK E. TURNEAURE,
Madison, Wis.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Machinery Hall, World's Fair.

Courtesy of "Tengwall Talk"

MECHANICAL.

An Important Test of Elliptic Springs.

BY S. A. BULLOCK.

The object of this test was to ascertain the greatest possible set this spring would receive under successive applications of light, heavy and excessive loads; and also to determine whether 106,000 pounds per square inch is an efficient fiber stress for the working load of plate springs.

Dimensions of spring before test:

Free height over bands	13¾ ins.
Free height between bands	6¼ ins.
Lenghth of spring over all	31½ ins.
" center to center	29½ ins.
Plates	3½x5-16 ins.
Numbar of springs per set	4
Number of plates per spring	9
Style of spring	Double elliptic

During the first six tests the loads were gradually applied and released by a screw testing machine, traveling at the rate of 3 ins. per minute. But in the last test, as shown by curve C (Fig. 5), an hydraulic testing machine was used. The weight-beam was so adjusted that the load could be partially released, and then suddenly forced band to band by moving the lever up and down by hand. For the use of their testing machines we are indebted to the Baldwin Locomotive Works.

This last test was made on a different spring of the same class as the one used in the first six tests, and we have shown it in Fig. 5 for the sake of comparison.

The spring steel was furnished by the Crucible Steel Company of America, and made into springs by the Standard Steel Works, from whom we have the following chemical analysis:

Carbon (ombined)	1.01	per cent.
Manganese	.310	" "
Phosphorus	.033	" "
Sulphur	.025	" "
Silicon	.170	" "

The first test (Fig. 1), consisted in giving 383 successive applications of the light load of 12,500 pounds, equivalent to a fiber stress of 91,400 pounds. (We have considered L one-half the length of spring under load P, to be equal to 15 ins.)

It is interesting to note that after the first application of the light load, and up to a certain number of applications (207), the spring grew 3-16 in. in the loaded height, the free height remaining constant. After this limiting number of applications, the successive applications of the load produced no further change.

The reason for this growth of spring, or increase of efficiency, is due to a decrease of friction between the plates. For in the manufacture of plate-springs there is always scale between the plates and the frequent application and release of this load pulverizes the scale, which then acts as a lubricant, and reduces the friction.

The second test (Fig. 2) consisted

of 12 applications of 14,500 pounds, or a fiber stress of 106,000 pounds, producing a set in the free height of minus 1-16 in. and a set of minus 1-32 in. in the loaded height.

The third test (Fig. 2) consisted of two applications of 20,000 pounds (fiber stress 146,000). No additional set was found.

In the fourth test (Fig. 3), the

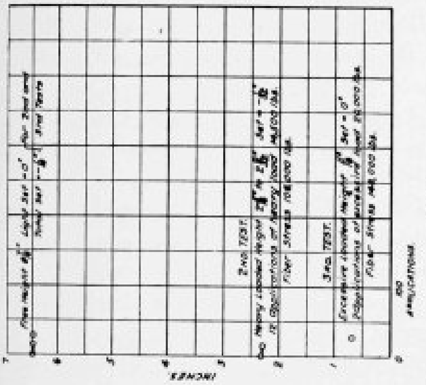


FIG 2.

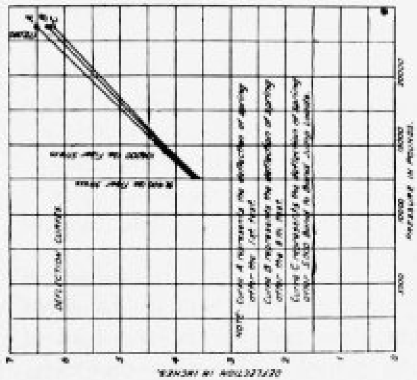


FIG 5.

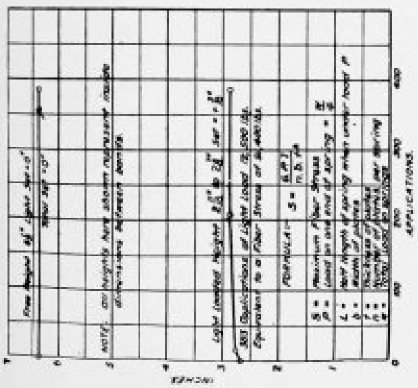


FIG. 1.

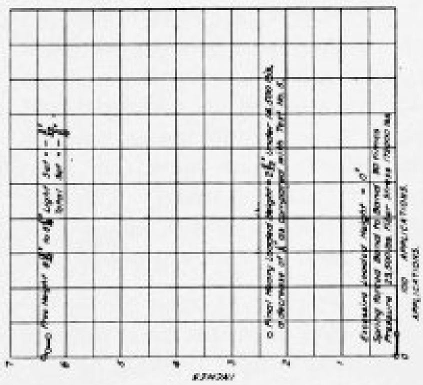


FIG 4.

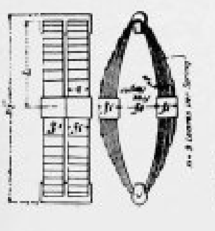


DIAGRAM OF SPRING.

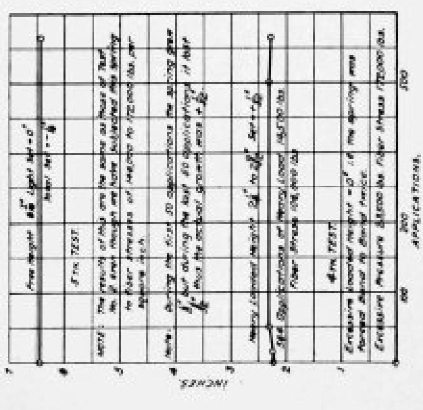


FIG 3.

spring was forced band to band twice, requiring an average pressure of about 23,500 pounds, or a fiber stress of 172,000 pounds per square inch. No appreciable set was discovered.

The fifth test (Fig. 3) consisted of 564 applications of the heavy load of 14,500 pounds, producing a fiber stress of 106,000 pounds. During the first 50 applications the spring grew ⅛ in., but lost 3-32 in. during the last 50 applications. Thus the actual growth was 1-32 in., the free height remaining constant.

The fifth test (Fig. 3) consisted of forcing the spring band to band ten times, then applying the test load of 14,500 pounds. This operation was repeated three times.

The first average pressure required to bring the spring band to band was 23,000 pounds, the successive average pressures required an additional 500 pounds to bring the spring band to band (i. e., 23,500, pounds or fiber stress of 172,000 pounds). The free height additional set was minus 3-32 in. The total light set was minus 3-16 in.

CONCLUSIONS.

Now, from these six tests, we note that 30 band to band applications produced a total set of minus 3-16 in. In the jump test between the 25th and the 5010th application the additional light set was minus 3-32 in. Accordingly, we may infer that the first spring could not receive a total set greater than minus 9-32 in., or that during the life of the spring, curve B (Fig. 5) would never fall below curve C.

Accordingly, it is evident that 106,000 pounds per square inch is allowable for the working fiber stress. The maximum allowable fiber stress can only be determined by more exhaustive experiments upon this subject.

Since all springs are at times subjected to excessive pressures which tend to produce a deformation from which the spring can never recover, we would suggest that when plate springs are tested they shall first be given two applications of that load which would be equivalent to a fiber stress of 146,000 pounds per square inch. Such a pressure to be quickly applied and released, the object being to relieve the spring of most of its set while under the testing machine, and thus insure ourselves against the annoyance of having the spring receive any permanent set when under the car.

—*Am. Engineer and R. R. Journal.*

On Machine Design.

The Editor of the Draftsman,
Cleveland, Ohio.

Dear Sir:—I would like to say a word or two on the subject of the article on "Machine Design." I doubt very much whether the graphic method of solution given on page 207 is quite reliable. I would ask, "What is there to prove in a case like this one (thickness of Babbitt) that a *straight* line drawn through the values for a large and a small machine will give correct values for intermediate sizes of machines?" If *three* sizes were "carefully designed" by computation of stresses, etc., and these being plotted, indicated a straight line to be the solution of the intermediate size, then certainly such straight line would equally give the values of other intermediate sizes, but if the plotting of the three calculated sizes indicated a *curve* line as giving the thickness of babbitt, then the value for all other intermediate sizes must be taken from this curve and not from the straight line.

Further, the very fact that the given values calculated from two sizes of machines, viz.:

5 in. bearing, ⅜ in. babbitt, and 2½ in. bearing, ¼ in. babbitt, are so disproportionate, is sufficient of itself to at once show that a straight line is not the correct solution of the thickness of babbitt for other sizes.

Again, the fact that the graphic method as shown by the straight line, Fig. 1, gives ⅛ in. thickness of babbitt as being necessary for a shaft having *no* diameter at all, at once proves that a curve line and not a straight line, is the proper solution of the problem. We have three points given from which the curve may be easily laid out or calculated, namely:—

Diameter	0″.	thickness	0″
"	2¼″	"	¼″
"	2″	"	⅜″

As to Misleading Information, page 218, what do you say to catalogues of Water Wheels or Turbines which give an efficiency of over 100 per cent.? One has to be very careful in accepting everything as gospel which is stated in a catalogue.

"Instruments for the Construction of Equivalent Geometrical Figures" by Jeremy C. Willmon, page 234. Please note that the "Triangie" described in this article is an exact copy of the triangle designed by me and copyrighted by me in 1892, a full description of which was given in "The Compass," Vol. II, November, 1892, page 64. This triangle was called the "Pi" Triangle, and was at once placed on the market. There is nothing new under the sun.

Very truly yours,
WM. COX.

Curious Facts.

The importations of pig tin last year were 68,000,000 pounds, against 7,000,000 in 1890.

Japanese warships equipped with wireless telegraph apparatus have sent and received messages to and from Japan at a distance of about 50 miles.

Twelve million pounds' worth of leather is required every year to provide boots and shoes for the inhabitants of Great Britain.

In honor of Peter Henlein, the inventor of the watch, a monument is to be erected at Nuremberg.

Leather waste is no longer wasted. Manufacturers use it in a compressed form instead of iron to make cogwheels.

If a man could use his legs proportionately as fast as an ant he would travel somewhere about 800 miles an hour.

Farm machinery saved in the planting and gathering of last year's crop in the United States $700,000,000.

A wine cask has just been built in California to hold 97,000 gallons. Its iron hoops weigh 40,000 pounds.

ARCHITECTURAL.

Beams and Joists.

BY GEORGE H. BLAGROVE.

Rolled iron beams are so much used in modern building that I am emboldened to draw attention to a few little points in connection with them and with construction attached to them, which are not always thoroughly understood or borne in mind by workmen.

First, as regards the strength of a rolled-iron beam. I have referred in a former article to tables showing the strength of rolled iron, which have been published by various firms of manufacturing engineers. Such tables are, as I have already stated, very handy for reference. Yet it will be as well, perhaps, to explain a simple method of calculating the strength of an ordinary rolled-iron beam, if only to show that there is nothing very complicated about such calculations, as too many people are apt to suppose. The usual rule is to take the sectional area of the bottom flange in square inches; multiply it by the total depth of the beam in inches; multiply this again by seven and divide the result by the span of the beam in feet. The result of this gives the number of tons required to break the beam if placed upon it in the middle of its span. If the weight is to be evenly distributed over the whole beam, instead of being concentrated in the middle, twice as many tons will be required to break it — that is to say, that in multiplying we should use the number fourteen instead of seven. In calculating the sectional area of the bottom flange this is taken up to where the straight part of the web commences, the required sectional area being the lower portion, shaded in Fig. 1. Rather a troublesome job, it may be thought, to calculate the number of square inches in such an irregular form with any degree of nicety. But a very simple rule, which ought to be more generally known, may come to our assistance here. In rolled-iron beams or bars of any uniform section three times the number of pounds per foot run, divided by ten, will give the area of the whole section in square inches. Referring to Fig. 1, we can easily measure the sectional area of the straight part of the web, which is unshaded, and deducting this from the whole sectional area, found by the preceding rule, the remainder is the united areas of the two flanges shaded in the diagram. These being usually equal, we have only to take half the result of our calculation for the required sectional area of the bottom flange.

The permanent load upon a rolled-iron beam should not exceed one-fourth of the weight required to break it, and it should not be tested to more than one-third of it. If any specimen of the iron has been broken, this gives us an opportunity to judge of its quality. The fibers of the metal should be long and silky, and the grain should not be coarse.

For constructional purposes it is often necessary to make holes in iron beams for bolts to pass through. The holes should be drilled, for if punched their sizes are apt to be unequal, besides which the metal immediately surrounding a punched hole is always more or less weakened. Much depends upon the positions of the holes, if the strength of the beam is to be economized. Remember that when a beam is supported at the ends and loaded from above it is subjected to two kinds of strains — one tends to stretch or tear asunder the lower part of the beam and the other tends to compress or crush the upper part. About midway between the top and bottom of the beam is what engineers call the neutral line, where the pulling and pushing strains are supposed to balance one another; and at this part the metal remains practically unaltered in form, however much the beam may bend, so long as it does not break. It is evident that the metal at the top of the beam is most severely compressed, while that at the bottom is most severely stretched; and the safest position for holes is at or near the middle, where they will least detract from the strength. Holes drilled in the lower part tend to widen by stretching, and obviously weaken the beam by reducing the resistance to tension; but holes drilled in the upper part tend to become reduced in size by compression, and they do not, therefore, weaken the beam, provided that they are completely filled by the bodies of iron bolts, which resist compression, preventing the holes from being reduced in size. Hence, if we have any choice in arranging the positions of holes in iron beams we should place them in the middle or upper part by preference. In calculating the strength of riveted girders, engineers always deduct the space traversed by rivet holes in the bottom flange, and this rule should be followed in respect to any bolt holes in rolled iron beams.

In ordinary wood-joisted floors, divided into spans by rolled-iron beams, there are more ways than one of connecting the joists to the iron beams. Many persons adopt the method shown in Fig. 2.


FIG. 1

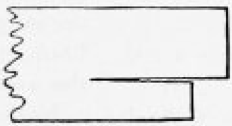


FIG. 3

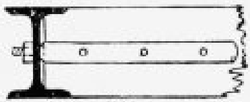


FIG. 5

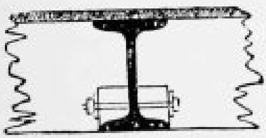


FIG. 2

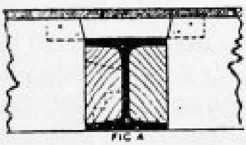


FIG. 4


FIG. 6

IRON BEAMS AND JOISTS.

Here a plate rests upon each bottom flange, being either bolted down to the flange, or, for better economy in drilling and bolting, bolted right through the lower part of the web. This drilling through the lower part of the beam is objectionable, as already explained. Besides this the joists are notched out for the plates, which weakens them terribly; indeed, it may be said that if an 11-in. joist is notched out 4 in. on its lower end, its strength is almost reduced to that of a 7-in. joist, so serious is the result of cutting away the bottom fibers of the wood, which resist the stretching strain. Under such circumstances the strain upon the joists is very liable to produce a split like that shown in Fig. 3.

A better method of attaching joists to an iron beam is by bolting a piece of timber against each side of the beam, for the entire depth between the flanges, and by tenoning the joists into these timbers on both sides, as shown on the left side of the diagram in Fig. 4. But there is considerable labor involved in cutting the tenons and mortises, besides which there is sometimes a practical difficulty in getting the joists into position. On the right side of the diagram the ends of the joists are simply cut to fit in between the flanges, each joist taking its bearing upon the bottom flange. By this means the joists obtain a more solid and even bearing (for the tenons may shrink unequally, throwing all the pressure upon one shoulder), and blocks of wood, cut to the proper length, are bolted in between the ends of the joists to prevent them from moving laterally.

Sometimes it is desirable for joists inserted against the sides of an iron beam to act as ties. This is especially the case when the beam is used as a shop breastsummer, the joists being required to assist in holding in the front wall of the building. This may be done by means of a strap-bolt attached to about every second or third joist by means of small bolts or screws, as shown in Fig. 5.

The form of such a belt, which should be all forged in one piece, will probably be understood from Fig. 6, where the bolt is seen in plan.

Another way of securing a tie is by means of L-straps, one arm of the L being bolted against the joist and the other against the web of the iron beam, or against the timber bolted to the web.

In cases like Fig. 2 and Fig. 4 the ceiling beneath and the floor above are easily managed. First, as regards the ceiling. Whether the under sides of the joists are flush with the bottom of the beam, or drop below it, all we need do is to fix the laths diagonally where they have to cross the beam. Then, as regards the floor. If the tops of the joists are flush with the top of the beam, as in Fig. 2, a floor board of sufficient breadth will lie upon the top flange of the beam, having each of its sides nailed or screwed into the ends of the joists; but if the tops of the joists are above the top of the beam, as in Fig. 4, fillets of wood are placed upon the top flange to receive the floor boards, and are either attached to the flange by means of screws or are nailed sideways against the joists, as shown in Fig. 4.—*National Builder.*

Glass houses of a very substantial kind can now be built. Silesian glass makers are turning out glass bricks for all sorts of building purposes.

HOME STUDY.

Use of Logarithms.

R. P. KING.

Logarithms are regarded by many machine designers as a bugbear, who immediately "pass up" all formulas containing them, while the usefulness of logarithms as a labor-saving device is neither understood nor taken advantage of as much as should be. In all my drawing room experience, I have seen but two or three machine designers who used logarithms in their calculation, except where absolutely necessary.

For the benefit of those designers who have had the advantage of high school algebra, but who have not fully understood the use of logarithms, I shall briefly outline the theory by which their use is mathematical. There are some minds that hesitate to accept anything mathematical that is not fully proved; such men will find the successive steps proved to their satisfaction. However, as there will be some who do not care to follow a course of algebraic reasoning, I will inclose the "letter" demonstrations in brackets, and they may be omitted if desired without losing the practical advantages of using logarithms.

There are at present in use two systems of logarithms. The natural (or hyperbolic) are used in analytical calculations and investigations, and are always denoted by the sign log .

The Briggs or common logarithms are, as the name denotes, the ones commonly used in every-day work. Wherever the sign log appears, the common logarithms are meant.

Logarithms are a comparatively recent discovery, being invented by John Napier during the first part of the 17th century. Napier was a Scotsman, born near Edinburgh 1550, and was an inventor and mathematician. He brought out his system of natural logarithms (often called the Naperian system) in 1614. No sooner did this work fall into the hands of John Briggs, professor of mathematics in Gresham College, London, than he began the investigation which resulted in the system of logarithms that bears his name.

Definition.—The logarithm of a number is the exponent by which a fixed number, or base, must be effected in order to equal a given number. This definition is perfectly general, and any number (with the exception of unity) may become the base of a system of logarithms. If we assume 3 to be the base and write $3^2=9$, then by definition the log. of 9 is 2. Similarly the log. of 27 would be 3 under such a system, because $3^3=27$.

Before proceeding further, let us review for a moment the laws governing the theory of exponents, for upon these five laws hangs the theory of logarithms.

$$a^m \times a^n = a^{m+n} \qquad (1)$$

$$\frac{a^m}{a^n} = a^{m-n} \qquad (2)$$

Cor. I $a^0 = 1$

Cor. II $\frac{1}{a^n} = a^{-n}$

$$(a^m)^n = a^{mn} \qquad (3)$$

$$(ab)^m = a^m b^m \qquad (4)$$

$$\frac{(a)^m}{(b)} = \frac{a^m}{b^m} \qquad (5)$$

These laws hold good for any exponent, either negative or positive, integral or fractional. They may be readily verified by referring to any work on algebra.

If $a^x = n$, then by our definition, x is the log. of n. Substituting in the equation $a^x = n$, letting $a = 1$, we have $1^x = n$ ∴ $x = \log_1 n$. But as $1^x = 1$, the equation will hold only when $n = 1$.

As 1 is the only number of which this fact is true, it will be readily seen that 1 is the only number that may not become the base of a system of logarithms.

Before taking up either of the systems in use, we should take a glance at some general propositions that are true for any system.

Log. of 1 is 0, for from Cor. 1 (2) $a^0 = 1$ ∴ $0 = \log_a 1$.

The log. of the base itself is 1.

$$a^1 = a \therefore 1 = \log_a a.$$

The log. of a product equals the sum of the logs. of its factors.

Let $x = \log_a m$ and $y = \log_a n$, then $m = a^x$ and $n = a^y$. Multiply the two equations together, $m\,n = a^{x+y}$ (1)

$$\therefore \log_a (m\,n) = x + y.$$

The log. of a quotient equals the logarithm of the dividend minus that of the divisor.

Let $m = a^x$ and $n = a^y$

$$m \div n = a^{x-y} \qquad (2)$$

Hence $\log_a (m \div n) = x - y = \log_a m - \log_a n$.

The log. of a positive number affected with any exponent, equals the logarithm of the number multiplied by the exponent.

Let $m = a^x$ Now whatever value we assign to p $m^p = a^{px}$ $\log_a (m^p) = px = p(\log_a m)$

From the principles above, we see that by the use of logarithms, the operations of multiplication and division may be replaced by those of addition and subtraction, and the operations of involution and evolution by those of multiplication and division.

From these laws we may deduce the following rules:

1. To multiply one number by another; find from a table the logarithms of the two numbers and add them together. Find from the table the number corresponding to this logarithm, and it will be the product desired.

2. To divide one number by another; find from a table the logarithms of the dividend and divisor, and subtract the latter from the former. Find from the table the number corresponding to this logarithm and it will be the quotient required.

3. To raise any number to any power; find from a table the logarithm of the number; and multiply it by the exponent of the power. Find from the table the number corresponding to this logarithm and it will be the power required.

4. To extract any root of any number; find from a table the logarithm of the number and divide it by the index of the root. Find from the table the number corresponding to the logarithm and it will be the root required.

These rules apply to any system of logarithms.

The Briggs or common system of logarithms has for its base 10. From one general equation we have

$$a^x=n \text{ and } x=\log._a n.$$

Writing the successive powers of 10 we have:

$$10^0=1 \quad \text{and} \quad \log_{10} 1 = 0$$
$$10^1=10 \qquad \log_{10} 10 = 1$$
$$10^2=100 \qquad \log_{10} 100 = 2$$
$$10^3=1000 \qquad \log_{10} 1000 = 3$$

and from Cor. II. (2)

$$10^{-1}=\tfrac{1}{10} \quad \text{and} \quad \log_{10} 0.1=-1$$
$$10^{-2}=\tfrac{1}{100} \qquad \log_{10} 0.01=-2$$
$$10^{-3}=\tfrac{1}{1000} \qquad \log_{10} 0.001=-3$$

If the log. 1=0 and the log. of 10=1, then the log. of any number more than one and less than ten will lie between 0 and 1 and will be a decimal. In the same way the log. of any number between 10 and 100 will lie between 1 and 2, and may be represented as one plus a decimal.

If we represent the decimal by the letter d and the numbers by 1+n; 10+n; 100+n, etc., we may form a general table of logarithms under the Briggs system.

$$\log 1=0 \qquad \log 0.1+n=1-d$$
$$\log 1+n=0+d \qquad \log 0.01+n=2+d$$
$$\log 10+n=1+d \qquad \log 0.001+n=2+d$$
$$\log 100+n=2+d$$

This is the principle of the Briggs system of logarithms. The log. is divided into two distinct parts, the *characteristic* and the *mantissa;* the characteristic being an integral, either positive or negative; while the mantissa is a decimal, represented above by the letter d, and which is added to the integral part or characteristic. For convenience in the use of common logarithms, mantissas are always positive. Hence the logarithm of any number less than unity consists of a negative, characteristic and a positive mantissa. The sign — over a characteristic indicates that it is negative. Thus, 3.851258 is the log. of .0071 and corresponds to the expression — 3 + d found in the general table of the Briggs system above.

The characteristic may be determined from the following rules:

1. If the number is greater than unity, the characteristic is positive, and numerically one less than the number of digits in its integral part.

2. If the number is less than unity, the characteristic is negative, and numerically one greater than the number of ciphers immediately after the decimal points.

And conversely: —

3. If the characteristic of a logarithm is positive, then the number will be greater than unity, and will have one more digit in its integral part than is numerically expressed by the characteristic.

4. If the characteristic of a logarithm is negative, then the number will be less than unity and will be separated from the decimal point by a number of ciphers one less than the numerical value of the characteristic.

Having thus found rules to guide us, both in the use of logarithms and in the method of determining the value of the number from the characteristic, we may turn to a table of logarithms and take up their practical application.

The mantissa or decimal part of the logarithm is the part we find in the table.

Considerable care and thought have been expended in arranging logarithm tables to secure uniformity of position and main and subdivisions which we easily distinguished, and which afford resting places for the eye, so that the labor of looking up logarithms has been greatly lessened.

As Kent's Pocket Book is found on nearly every drafting table, so for this article we will use the table of logarithms found therein, although it is not the best table in use.

This table gives the logarithm of every number from 1 to 10,000, and by interpolating we may approximate to 100,000.

The log. of any number to 100 is given directly in the first division of the table, the characteristic and mantissa both being given: — For instance, the log. of 71 is 1.851258.

If the table had not been so constructed, but had started at 100, the log. of 2 — 3 — 4, etc., and of numbers having 2 digits, as 73 — 87, etc., would have been found under 200 — 300 — 400, etc., and under 730 — 870, the mantissa being the same in both cases, the characteristic only being changed.

The second part of the table is, however, constructed a little differently, the mantissa only being given. The mantissa of numbers from 100 to 1,000 being found in the second column under the figure 0 opposite their respective numbers; the characteristic being 2, from the rule already given. For instance, the log. of 585 is 2.767156; the log. of 956 is 2.980458, etc.

The logarithms of numbers between 1,000 and 10,000, and ending in 0 are found in the same way, but have a different characteristic. For instance, the log. 5850 is 3.767156 (note log. 585.), log 9560 is 3.980458, etc. The log. of 5854 is found opposite 585 in the column under 4, and is therefore 3.767453.

Referring to the general table on Page 12, where log. $1 + n = 0 + d$, etc., if n is constant, then d is also constant; from this we may deduce the following:

Log.	.005854	=	3.767453
	.05854		2.767453
	.5854		1.767453
	5.854		.767453
	58.54		1.767453
	585.4		2.767453
	5854		3.767453
	58540		4.767453 etc.

To find the log. of a number greater than 10,000, we resort to interpolation. For instance, log. 58547 is greater than log. 58540 and less than log. 58550.

	Log. 58550	=	4.767527
	58540	=	4.767453.
Difference	10		74.
	58547		
	58540		
Difference	7.		

If a difference of $10 = 74$ at this point in the logarithm series, then a difference of 7 would be 7-10 of 74 or 51.8 (approximately).

	Log. 58540	=	4.767453
Add difference	7	=	51.8
∴ Log. 58547=			4.7675048.

The difference (74) may be found in the column "diff." opposite this number 585, and the proportion 7-10 $= 51.8$ is found below in the table of proportional parts, so the work of interpolating is largely mental.

To find a number from a logarithm,

the operations are reversed.

From rule 1 we see that to multiply two numbers we have to add together the numbers.

Example I —67.4 x 43.21 = ?

log. 67.4 1.828660
log. 43.21 1.635584

3.464244

3.464340 = log. 2913
3.464191 log. 2912

149 diff. (Note diff. in margin at right. Kent P. 139)

3.464244
3.464191

53

53/153 = 35 (nearly.) Do not carry these proportions out too closely.
2912+.35=2912.35 and 67.4 x 43.21=2912.35. Ans.

Ex. 2. 74.62 ÷ 41.7= ?
log. 74.62 1.872855
log. 41. 7 1.620136
.252719=log. 1.789 +
∴ 74.62 ÷ 41.7=1.789+ Ans.

Ex. 3. 46.52^2 = ?
log. 46.52 = 1.667640
3
4.992920=log.98383.+Ans.

Ex. 4. $\sqrt[3]{6734.2}$ = ?
log 6734.2 = 3.828286
divide by 3 = 1.276095 = log 18.884 + Ans.

Ex. 5. Solve $d = .239\left(\frac{76.2}{\left(\frac{41.32}{5641}\right)^{\frac{1}{2}}}\right)^{.386}$

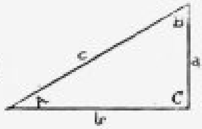
log. 41.32 = 1.616160
log. 5641 = 3.751356
3.864804
.5(=½)
.4324020
— 1.5
2.9324020

Notice in this last operation the use of a negative characteristic with a positive mantissa. The multiplication is done separately. The term — 1.5 is entirely different from 1.5; in the latter case only the characteristic is negative. The term — 1.5 = — 2 + 5, and in the work above is so treated. Instead of using the decimal .5 to find the square root above, it would have been possible to divide by 2 as follows:

2 | 3.864804 =
2 | —3+1.864804
2.932402 (substrahend)
log. 76.2 = 1.881955 (minuend)
2.849553
.387
multiplication omitted
1.102677
log. 239 = 1.378398
.481075 = log. 3.02745
Ans.

The method by logs. is the only method practical for a complicated equation like the above.

Ex. 6. Solve the following triangle.

47.653=c  a=21.34

Sin A= a / c
log. 21.34 = 1.32919
log. 47.653= 1.67809
log. Sin A= 1.75110=9.65110—10
∴ A = 26°—36′—14″
Cos A=b / c
log. 47.653 = 1.67809
log. cos. 26°—36′—14″=9.95140—10
log. b =1.62949
∴ b =42.608.

In this last example the log. sin., log. cos., etc., are from a table of log. functions not found in Kent's Pocket Book. Such tables are in civil engineers' field books, works on trigonometry, etc.

The hyperbolic system requires a somewhat different treatment when in use. The table of hyperbolic logarithms, or log. e as I shall hereafter call them, in Kent's Pocket Book is a very full one, due possibly to the fact that Mr. Kent is notably a steam engineer.

The general principles of logs. apply here, but in this case the characteristic and the mantissa are inseparable.

The base of this system or value of e is 2.718281 instead of 10, as in the common logs.: log. 2.718281 = 1.00.

Log. e are not used in such calculations as multiplication, as they are not so readily handled as common logs. A table of log. e from 1 to 100,000 would be about the size of a Webster Dictionary. These logs. will be used by a designer mostly in formulas when a direct substitution is all that is necessary. Take for instance the mean effective pressure of steam in a cylinder where steam is cut off at 1-5 stroke, assuming 17 pounds back pressure and steam at 100 pounds gage:

$$\text{Formula } P = p \times \frac{1 + \log_e. R.}{R} - B.$$

P. = M. E. P.
p. = Gage pressure.
R. = Ratio of expansion.
B. = Back pressure.

$$P = 100 \times \frac{1 + 1.6094}{5} - 17.$$

The reader can solve for himself. Should the table not contain the log. e required, it may be found by multiplying the corresponding common log. by 2.302585.

The child of the logarithm is the slide rule which is as much of a time saver over its parent as the log. is over the long method.

If the reader will take a piece of bristol board (or drawing paper) 11" x 2" long, ruled as in Fig. 1, he can, with a very little labor, make a paper slide rule that will give very satisfactory results.

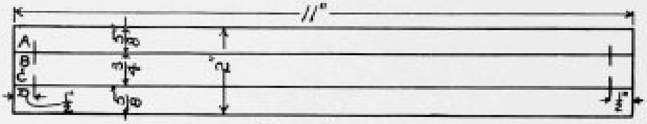


FIG. 1.

Scales A and B are to be exactly alike and scales C and D will also be alike. Take the table of logs. in Kent, and starting at the left measure with an engineer's scale, 3."01, mark the point 2 (see Fig. 2) and draw the cross line —. It will be noticed from the table that the log. of 2 is .301 +, so that we have multiplied the mantissa of log. 2 by 10, in order to make our scale of reasonable size. In the same manner measure off a distance found by multiplying log. 3 by 10 (4."77) and mark it 3.

To find point 4 take twice the distance 1 — 2 point ;5, measure back from points 10 the distance 1 — 2; for point 6 add distance 1 — 2 to distance 1 — 3; point 8, add distances 1 — 4 and 1 — 2; point 9 is twice distance 1 — 3 —, etc., etc.

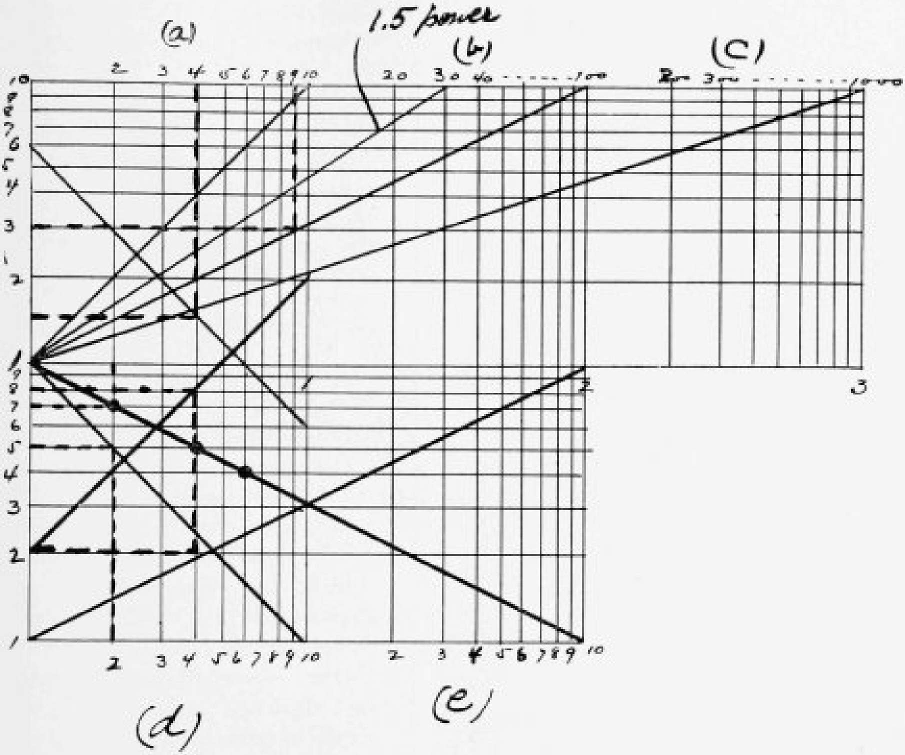
The reason of this is apparent from the rules for use of logs., viz., adding logs. instead of multiplying numbers together, and subtraction of logs. instead of dividing numbers.

The distances 1.1 — 1.2 — 1.3 — are found from the mantissa of logs. 11 — 12 — 13 —, multiplying by 10 in each case, and will be 0."41 — 0."79 — 1.11, etc.

Scales A and B are the same as C and D except that they are one-half the size.

Fig. 2 shows the rule complete. Paste the outside edges to a piece of cardboard, and when dry, cut carefully along the long lines, cutting the

Fig 5



centre completely out. We now have the slide rule complete.

To multiply, we have only to add distances on the rule. For instance, to multiply $35 \times 45 = 1575$. The rule gives results to 3 places, and the last one (5) is known by multiplying the last figures together mentally.

The method of procedure is as follows: Push the slide to the right until 1 of scale B comes opposite 3.5 of scale A (see Fig. 3). Opposite 45 of scale B can be read the result on scale A. Had the dimensions on the scale been smaller, the work of interpolating would have been easier. Right here let me say that the interpolating is the hardest part of slide rule work. After one has acquired the knack of quickly and accurately dividing the small divisions on the scale, he can perform the ordinary operations with a rapidity that is little short of supernatural. By this, I do not mean "slide rule

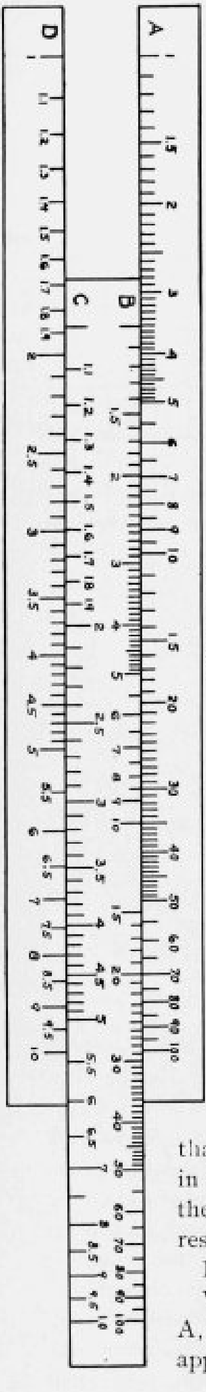


FIG. 3.

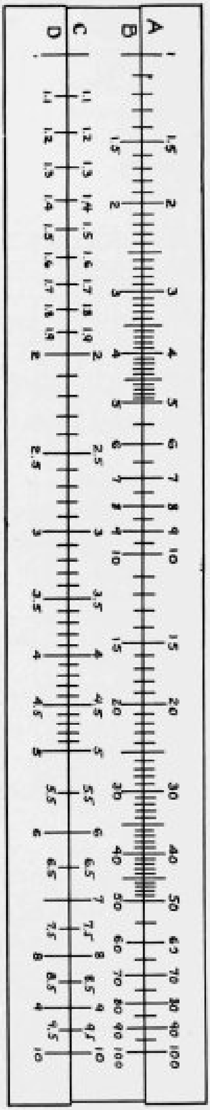


FIG. 2.

gymnastics," but the plain multiplication and divison of every-day work.

As scale A is half the size of scale D, a distance 1—5 say, on scale A, equals the corresponding distanee $\frac{1—5}{2}$ on scale D. Now as these distances equal logs., this is equivalent to squaring and extracting the square root of numbers. Ex ∴ To $\sqrt{3.5}$—Fig. 3 place 1 on scale B opposite 3.5, the root is found on scale D opposite 1 of scale C, and is 1.87.

Ex. $\sqrt{31.5}$ = ?

Opposite 31.5, scale A, is 5.6, scale D.

From 1 to 10, scales A and B, is one complete scale, and as we know, is exactly like the portion 10 to 100, on scale A and B. Let us call 1—10 section a, and from 10 to 100 section b. In keeping track of the decimal point when multiplying, we use this sectional division. If the result is found in the same section as the multiplicand, the answer will contain one digit less than the sum of the digits in the multiplicand and the multiplier. Ex. 2×4=8

2 has 1 digit.
4 has 1 digit.

2 digits

Multiplicand and answer are found in the same section; therefore the answer has one less digit than the sum and is therefore 8 and not .8, 80, etc. Of course, in this case we know the result has 1 digit, but in larges factors the result isnot so easily known. If the factors are 2×6, the result 12 will be in the next section and will have 2 digits.

In division the converse of the above will be true.

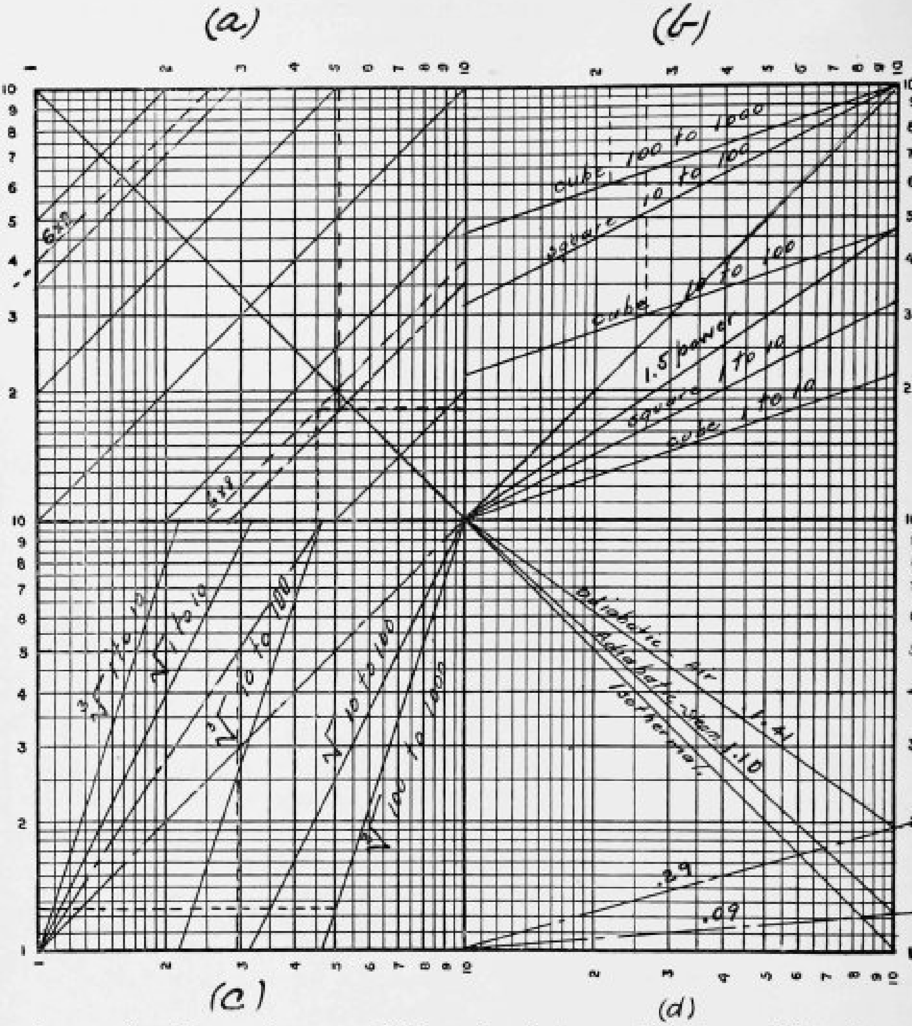
When squaring, if the square appears in the first section, scale A, it will contain twice the number of digits minus one that appear in the root. If the square appear in the second section, it will contain twice the number of digits that appear in the root, while the converse is of course true for square root.

For other operations on the slide rule, the reader is referred to works upon that subject. Cubes and cube roots are not very satisfactory problems on the slide rule. The best way to solve problems of involution and evolution other than squares and square roots is by the use of logs.

For solving certain equations and problems it is quite often possible to use a cross section paper ruled to correspond to a series of logarithms. Fig. 4 is a sheet of such paper as may be procured of dealers in draftsman's supplies. The distances 1 — 2, 1 — 10, etc., correspond to the mantissa of common log. in precisely the same way that spaces on the slide rule did, and may be to any convenient scale. Fig. 5 is the same thing with different lines and to a smaller scale.

In square (a) Fig. 5, the diagonal line 1 — 10 is the line of unity and will intercept equal values on the horizontal and vertical lines, for as the line 1 — 10 is at 45 degrees, it is apparent that the vertical distance is the same as the horizontal distance, and a horizontal line would intercept a vertical line of the same value. If, however, we draw the 45-degree line extending diagonally upward from 2, we shall have added the vertical distance to each horizontal distance on the paper. Therefore, to multiply any number by 2, we have only to follow up from the bottom along the line representing the value we wish to multiply by 2, and the intersection of the vertical line with the diagonal from 2 will be on the horizontal line representing the value of the result. Suppose we follow the vertical line 4 upward from the bottom section (d): The line crosses the horizontal line 2. Pausing here a minute we may conceive a rectangle bounded by the dotted lines in this section, and as we know that the diagonal line is at 45 degrees, this figure must be a square. We have the value of the horizontal side of the square as 4, therefore the vertical side is four, and as we have already come a distance of 2 the diagonal line marks the sum of the logs. of 2 and 4, which equals log. 8 as shown by following the horizontal line toward the left. Portions of two sections are required to complete the number of multiplications by two, but by referring to section (a) Fig. 4, it will be seen that a portion of the diagonal line from 2 runs diagonally to the right, and the remainder runs from the opposite end of the 2 line, diagonally to the left. By this means all the calculations may be made in a single square.

Let us apply this to a formula having but one variable. A piece of 6 x 8 timber, one foot long, contains 4 board feet. Draw from 4 in (a) Fig. 4, the dotted diagonal extending upward, completing the line by drawing the dotted diagonal from the right hand end of the line 4 but extending downward. If we have a stick of timber 45 feet long, from 45 follow the dotted line upward to the diagonal intersection, then along the horizontal to the right, and the answer will be 180 board feet. If the piece is $28.00 per *M*, draw the dot and dash line diagonally upward from 28 on the bottom scale, and at the intersection of this diagonal with the line of resultant board feet,



change direction and go vertically, reading the result in dollars at the top, which in this case is $5.04.

In section (d) Fig. 5, we have a line running downward diagonally from 1 to 10. This line is the line of reciprocals and gives us all the factors of 1.

Starting at 5, follow the horizontal line to the right, intersecting this diagonal, then downward along the vertical line and read the reciprocal of 5 on the bottom, which is 2. This diagonal intersects the scale lines in such a way that the sum of the intersected horizontal and vertical lines equals 10.

Draw the diagonal line downward from 6 in section (a) Fig. 5, and we have a line of inverse proportion. This line operates in precisely the same way that the reciprocal line did except the factors will be the factors of the number from which the line started instead of being factors of one. These lines may be used to solve all problems of inverse proportion, and will be especially adapted to finding the speed of pulleys and gears. Taking the diagonal line from 6 as an example; a pulley 20" dia. runs 300 R. P. M. This 20" pulley belts to a countershaft which is to run 1,500 R. P. M.; required the size of the pulley on the counter. From 15 follow the dotted line toward the right to its intersection with the diagonal, then up, reading the result in inches, in this case 4".

To square a number we multiply the log. of the number by 2, the result being the log. of the number squared. Draw a line from 1, section (a) Fig. 5, to 100, section (b). We have formed a triangle, the base of which is twice the altitude, so that by similar triangles we know that any vertical will intersect the slant line at a distance from the left or apex vertical, equal to twice the length of the given vertical. Start at 3 and follow the horizontal to the right and at the intersection with the slant line, change direction and read the result 9, at the top.

The slant line 1, section (a) to 1,000, section (c), will, in exactly the same way, be the line of cubes. At section (b) Fig. 4, is shown the usual way of lining a section for squares and cubes, and (c) Fig. 4, is the lining for square roots and cube roots. In Fig. 5 it will be noticed that the 1.5 power is drawn to a point midway between the unity line and the line of squares.

At Fig. 5 (d) and (e), we have again the line of squares. From 1, section (d), draw a slant line intersecting the square line on the vertical 10, terminating of course at 10, section (e). This line will represent a value by the equation $x\sqrt{y} = 10$.

The dots represent several solutions involving two variables and are successively $7\sqrt{2.04}$... $5\sqrt{4}$... $4\sqrt{6.25}$.

In section (d) Fig. 5, we have the lines of isothermal and adiabatic expansion under certain conditions. The co-efficient .29 represents the exponent for the ratio of expansion of air by heat and is from the exponent 1.41 of the adiabatic equation, thus, $\frac{K-1}{K}$, and to draw this line a distance is measured upward from 1 on the line 1 — 10 at the right equal to .29, the distance 1 — 10. In the same way we find the exponent .09 from 1.10, the right end of the line being .09, the distance 1 — 10 measured from 1.

By means of these lines, adiabatic expansion curves may be drawn, using any exponent for the adiabatic equation such solutions involving a minimum labor and practically no figures.

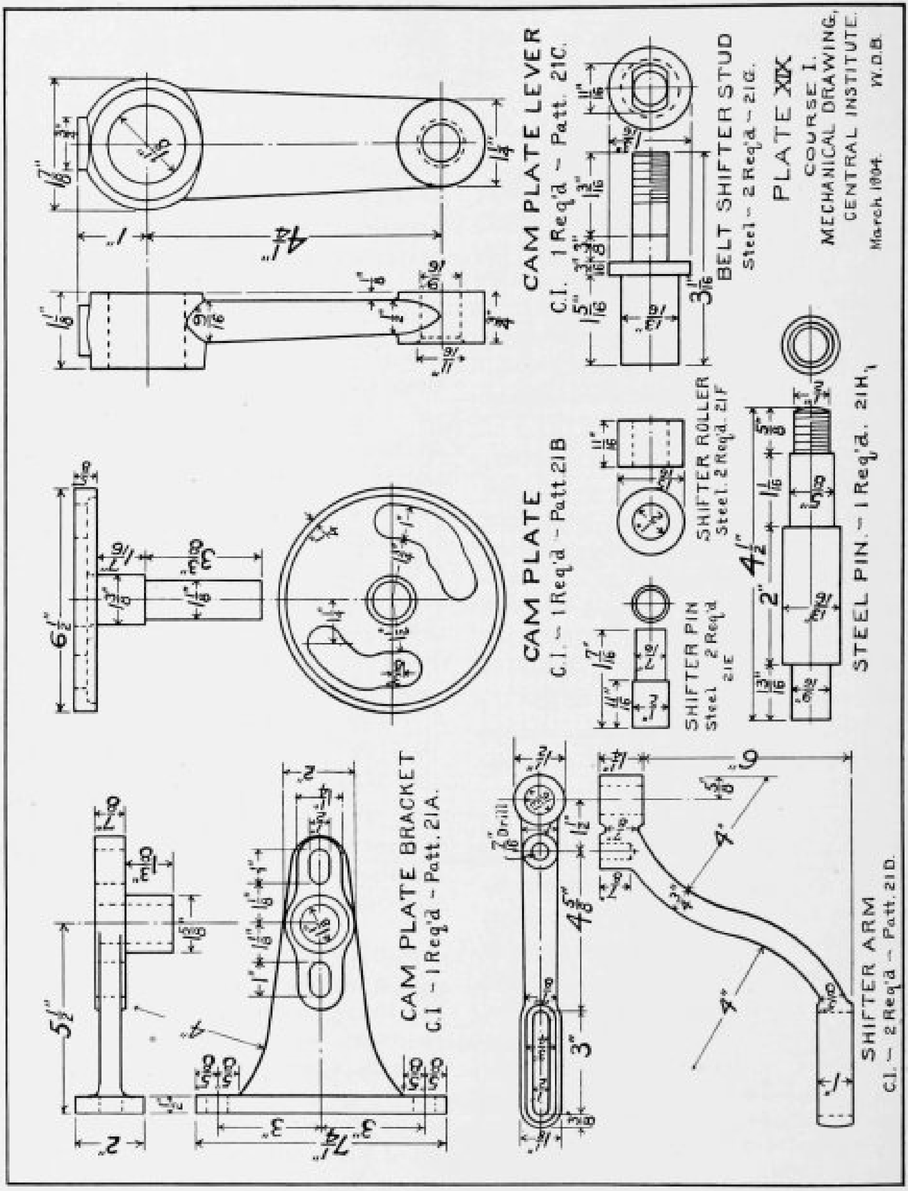
If the reader has mastered the principles of logs., he will have no difficulty in grasping and using these practical applications. There are other uses for logs. and labor saving devices connected with them which the reader is left to discover for himself.

The automobile principle has been applied in Paris to baby carriages. The nurse sits behind and regulates the speed, which does not exceed a moderate figure.

The greatest clock in the world, the dial of which will be 120 feet in diameter, is being built at Milwaukee for use at the Louisiana Purchase Exposition this year.

Elementary Mechanical Drawing.

(Contiuned from June Issue.)



(Continued under head of "Current Topics")

CURRENT TOPICS.

With next issue of The Draftsman, the Elementary Course in Mechanical Drawing is completed.

The whole series of articles are to be revised and published in two parts or divisions. The course has been used quite successfully at The Central Institute, Cleveland, O., and is the first course in their catalog.

Part III. and Course II. of the Mechanical Courses of this school will receive attention next.

Part I., Architectural Course, at this school is the same as the Part I. Mechanical, and Part II, Architectural, will begin in our

"Home Study Department" in the August issue.

If there are any of our readers who would like to use this course in day or night schools, we would be pleased to hear from them.

(Continued from "Home Stuty,,

The student is now requested to copy the matter as shown on Plate XIX and finish it up complete with dimensions, inscriptions and title, with the border and margin as on the regular sheets.

Use a neat and uniform size of lettering and figures, putting them in in pencil and submit to the instructor for approval before inking. Keep the title well together and not let it appear as if it were a part of the inscription just above. Exercise care in arranging objects so not to leave too much space at the side or bottom.

Do not remove from the board until you have made Plate XX which is to be a tracing of Plate XIX. Look over the instructions on "Tracings" on a previous page.

Plates XXI and XXII.

"Indispensable" Combination Drawing Set.

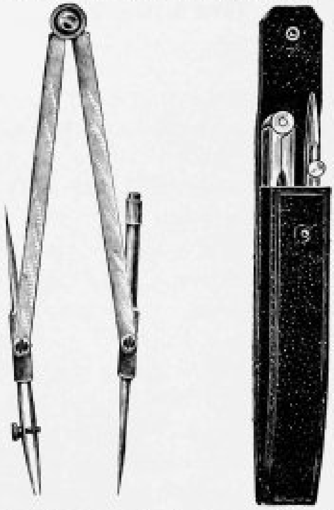
BY KOLESCH & CO.

A cheap, portable, yet strong and accurate pair of pocket compasses has long been the wish of all whose occupation involves the use of drawing instruments, builders, draftsmen, mechanics, engineers, surveyors, architects, students, etc. Heretofore all pocket compasses were either too cheap to be moderately accurate, and durable, or so high in price as to forbid their coming into general use.

Messrs. Kolesch & Co., New York, have at last succeeded in constructing an instrument, which overcomes these drawbacks, while it embodies strength, accuracy and durability.

The "Indispensable" Combination Drawing Set, as shown in illustration, consists of a pair of divider's pencil compasses and pen compasses in one piece. As can be seen in the cut, the pen and pencil point are each made integral with one of the steel points and each one of these pieces is firmly riveted to one of the legs; it is reversible, so that either the steel point or the pen and pencil point can be brought down on the drawing surface. By this method there are no loose parts or screws, which might get lost, while the instrument is readily adjusted for use. The instrument is made of strong steel-metal, bent and braced, to make it as light and rigid as possible. The joints are very strong and of an improved style, so that they will never lose their adjustment. When closed the instrument measures only 6¼" x 5-16" x 7-16" and weighs only ¾ oz. The instrument is nicely finished and nickel-plated.

The "Indispensable" Combination Drawing Set is also furnished in a



neat, strong pocket case with clasp, which also holds a good 5" ruling pen. The dimensions of the case are 5" x 1" x ⅜" and the weight is only about one ounce. On account of its lightness and compactness this set can be conveniently carried in the vest pocket and is intended "Indispensable" especially for out-of-door work.

The "Indispensable" Combination Drawing Set, sent postpaid, for 75c.

The "Indispensable" Combination Drawing Set with 5" ruling pen in vest pocket case, sent postpaid, for $1.25, by

KOLESCH & CO.
138 Fulton St., New York.

Thirty-seven per cent of the American people now live in cities of more than 4,000 inhabitants.

Dear Sir — In your December issue I noticed an article under the heading "Something for Our Geometrical Friends." At the time I thought the printer had made a mistake or that the writer thought the intelligence of your readers was considerably below par. At any rate, I thought everybody who was interested would see the error and that it was not worth while to take up your space in answering it, but seeing in this month's issue that Florence W. has taken the matter up, and was airing her mathematics by making a mountain out of a molehill, I would like to show you how she could have saved your valuable space and also the patience of your readers.

Mr. Babbitt sets forth in the first line of his proof that "*The* line H E (the perpendicular bisector of BD)," etc. Now the line H E is not the perpendicular bisector of BD which any one can prove without taking your space, and having taken for granted that which is wrong, his whole proof is wrong, so why bother with an absurdity.

I might add again that some people jump at conclusions without much thought. Florence W. starts out by saying, "The error is found in the assumption that KE equals CE. Now I claim that KE does equal CE, seeing that HE was made a perpendicular bisector to KC. Therefore KEC is an isosceles triangle. Yours truly,

H. W. GOCHER.
Seattle, Wash.

In Sweden bricks are laid in zero weather by heating the sand for the mortar.

Sweden sent three-quarters of four million gross boxes of matches imported into this country last year.

Cox Computers.

Civil, mechanical, electrical, hydraulic and other engineers have in their professional work many problems, more of less complicated, to solve over and over again by means of the same or similar formulas. The routine work thus caused often becomes so wearisome that any method or device which facilitates this tiresome labor is gladly welcomed. The oldest device, and one which cannot be too highly valued as a labor saver, is the slide rule, but its use in the case of complicated formulas is somewhat tedious and uncertain, unless the manipulator has had considerable practice with it and is quite sure of his ground. Others find the graphical method by means of diagrams a great help, whilst many others plod along and solve their problems as best they can by the old-fashioned arithmetical or (perhaps in some cases) logarithmical method.

A new device for solving some of the most tedious engineering problems has come into more or less general use during the last 12 or 14 years, namely, Cox Computers. Each computer is designed to solve by simple mechanical means one well-known formula, such as those relating to the strength of shafting, belting, gears, beams, or the flow of air, gas, water, etc., in pipes, and many others of similar complex nature. Cox Computers consist in their simplest form of a foundation plate in the center of which a disk revolves. Upon these logarithmic scales corresponding to the several factors of the formula, are arranged and combined in such manner that by turning the disk round and bringing the values of two of the known factors of the formula upon contiguous scales opposite each other, the value of the unknown fourth factor is at once seen opposite the known third one. When there are 5 or 6 factors in the formula, an extra piece of sectoral shape with similar scales upon it, revolves between the disk and the plate about the common center.

One very important feature which adds considerably to the value of these computers, and which has been so thoroughly appreciated, is that in problems of which many solutions are possible, all the different values of the correlated factors which would produce the *same result* are at once read off, so that all that remains to be done is to select the most suitable value for each factor. Thus, in the case of the computers for the strength of gears and rectangular beams, the pitch and face of the former and the breadth and depth of the latter are correlated. When solving such problems arithmetically, the value of one of these terms must be assumed and the other one calculated from it, only to find perhaps that the combination of values thus obtained is quite unsuitable, and the work must consequently be all done over again. With Cox Computers, however, a suitable combination of values of such correlated terms can be at once selected from the whole range of possible values, all of which produce the same result. In this way, not only are hours of tedious calculation avoided, errors eliminated, but the solution of the problem is obtained with a far greater appreciation of the effects produced by a slight modification of any one of the factors of the formula than is possible by working out arithmetically any number of suppositional cases by means of the formula.

In the case of formulas containing a variable co-efficient, no attempt is made to decide upon a fixed value of the same, but a special scale is provided covering all probable values from which the user may select the one which accords with his judgment, precisely as he would do if he were solving the formula in the usual manner.

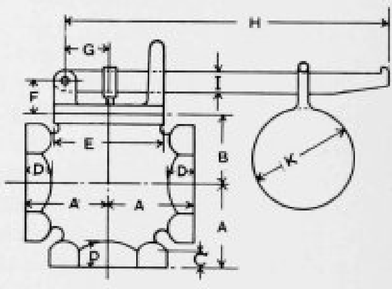
These computers are made of the best bristol board, and the sizes vary from 4½ by 6 to 12 by 14 inches. The smaller ones are generally put up in cloth or leather cases, while the larger ones, which are more suitable for drafting room or office use, are mounted on substantial cloth covered binder's board.

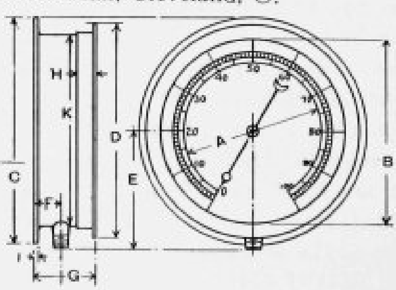
Thousands of Cox Computers have been sold, and they are used by engineers in every English-speaking and many foreign countries, from Norway to South America, and from Canada to New Zealand. The most flattering opinions have been given unsolicited as to their "convenience, accuracy, unquestioned value, simplicity," etc., by engineers of the highest standing in their respective professions, who use them regularly. To such their cost is saved in one day by reason of the increased amount of work they have been able to get through, whilst as a means of checking calculations made in the usual manner, they are invaluable.

A New Book for Draftsmen.

For the draftsmen who have to lay out drawings in which any pipe work may exist the book, "*Pipe, Fittings and Valves*" will be indispensable. There are over 50 tables of articles used in pipe work and the dimensions and illustrations are very complete.

Every draftsman, architect and engineer should have one in a handy place so when called upon to lay out such work he may do it rapidly. Bound in flexible cloth, postpaid, 50c. The Draftsman, Cleveland, O.





A few illustrations out of "Pipe, Fittings and Valves.

A Convenient Drawing Board and Curves.

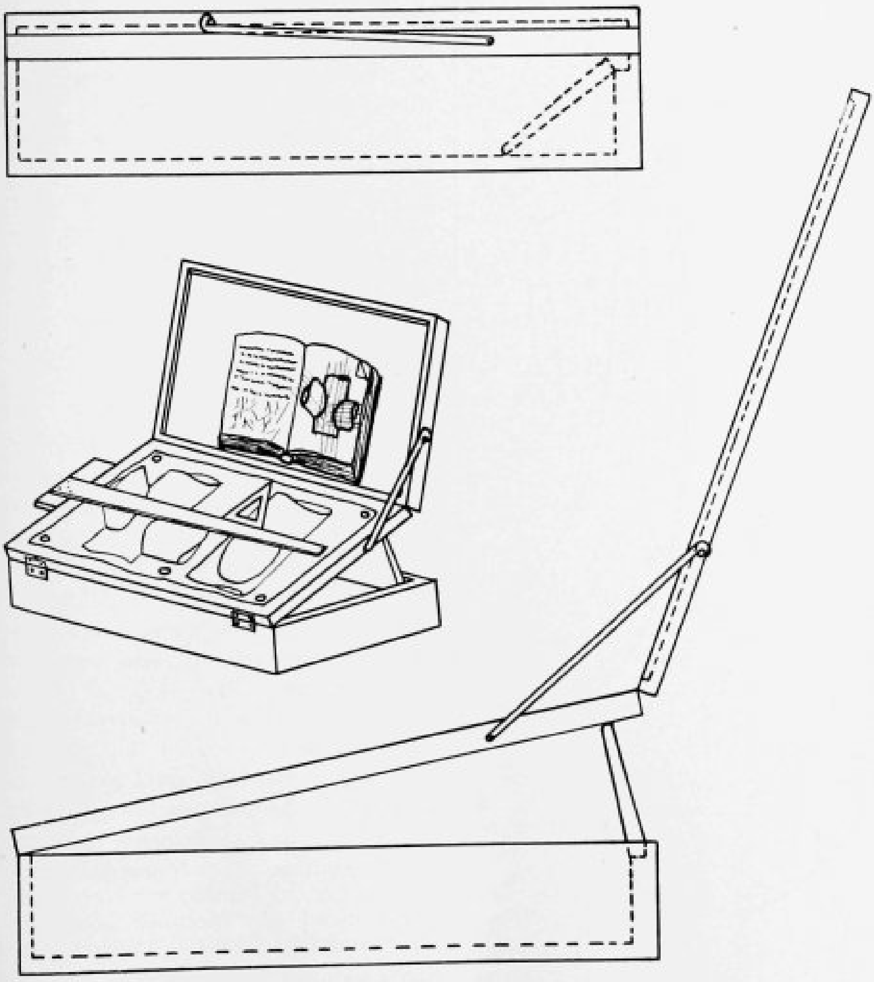
R. W. DICKENSON.

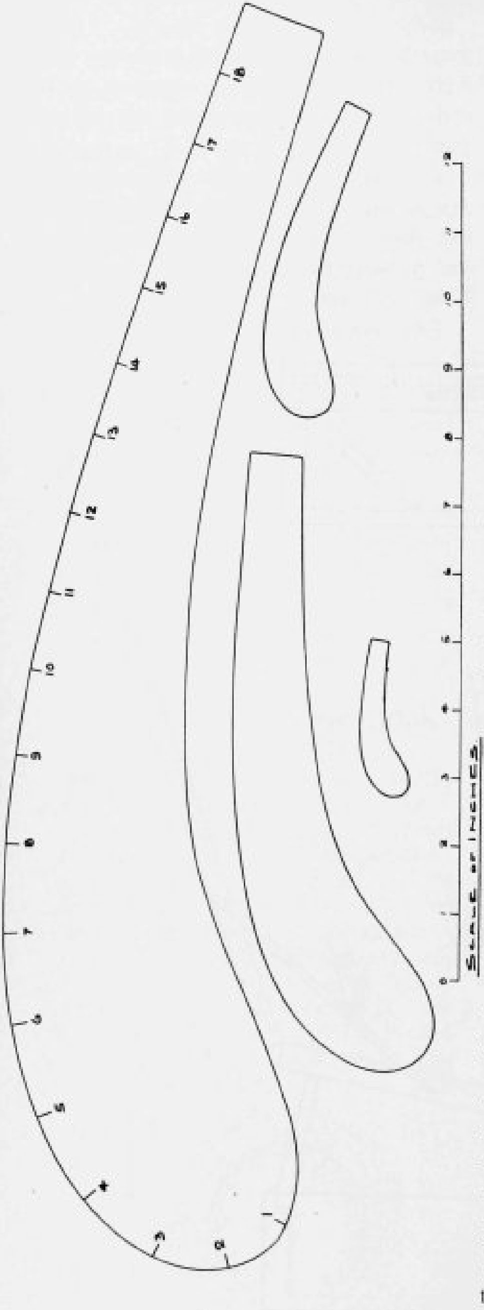
I have not had time to go into the board design yet, but you will find enclosed two sketches which you may find useful in the meantime.

The set of four curves have proven themselves extremely useful for a number of years, doing away entirely with French curves. Being made in full, half, quarter and eighth sizes, makes them more useful, and being a generated curve, it is only a matter of a few minutes to make one any size out of cardboard or thick drawing paper.

They are made of clear celluloid and are all figured the same as the large one shown. If anyone desires to know the method of setting the curve out, I will send on same later.

The other sketch, I think, explains





itself. The bottom base serves to hold spare paper, finished drawings, instruments, paints, etc., the drawing board forming a lid for same. The lid for the board serves also to hold books and drawings when open as shown.

As a set for home use, I think it cannot be beat.

Book Notes.

A neat little volume, compiled with the view of placing before yachtsmen and the reading public who are fond of blue water, some interesting and useful information.

The author has to his credit several other good books of a nautical nature.

The above book has much of value for even the landsman, and if one contemplated a voyage it would be a valuable adjunct to his library. It is well bound, pages 3½ x 5¾, price 25c. Published by Gardner & Cox, No. 1 Broadway, New York.

Three of the illustrated "*Carpenter and Builder*" series of technical manuals have been received. This series consists of several neat books, entitled Bricklaying, Slating and Tiling, Joining, Decorating, Plumbing, Masonry, Concrete, Artificial Stone, Terra Cotta, etc., Home Handicrafts, Painting and Varnishing, Plastering.

These useful and instructive books are especially prepared for self-instruction, printed on good paper and illustrated wherever the subject needs it. Price 25c. Descriptive circulars free. Address The Industrial Publication Co., 16 Thomas St., New York City. Send for specimen pages of their monthly journal, "Self-Education."

Dotting Pen.

Ernest G. Ruehle, of New York, N. Y., has invented a new and improved dotting-pen.

The purpose of this invention is to provide a simple, durable and economic dotting-pen, thoroughly effective in use and which may be conveniently and expeditiously cleaned, and so constructed that reserve dotting-wheels of various sizes may be carried in the body of the pen, and so that the dotting-wheel at the point of the pen can be readily removed to be cleaned, sharpened and replaced.

A further purpose of the invention is to provide a feeding device for the ink, located within the body and comprising two opposing members oppositely bowed or curved secured at one end of the inner faces of the members of the body of the pen, the outer ends of the members of the feed device being free and pointed and made to more or less closely approach the periphery of the dotting-wheel and to provide each member of the feed device with means of adjustment independent of the adjustment of the body of the pen, whereby the feed device may be supplied with ink in the same manner and as conveniently as the ordinary drawing-pen, insuring a regulated, uniform, and reliable supply of ink to the dotting-wheel under all conditions of use.

The invention consists in the novel construction and combination of the several parts, as will be hereinafter fully set forth, and pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a front elevation of the improved pen. Fig. 2 is a side elevation of the same; and Fig. 3 is a sectional front elevation of a compass-pen, illustrating in dotted lines the pivoted member of the limb in open position.

A represents the body of the pen, and B the handle which is to be employed when the pen is to be used as a regular drawing-pen; but in Fig. 3 I have illustrated the body of the pen as pivotally attached to a block B′, having a polygonal stem B^2, adapted to enter a socket in a limb of a compass. The body A consists of two oppositely bowed or curved members *a* and *a′*, both of which are connected with a head member a^2, the member *a′* being pivotally connected to the said head member, and in the ordinary form of the pen the handle B is attached to the head member a^2, and when the pen is to be used in connection with a compass the aforesaid block B′ is pivotally attached to the said head.

The lower terminal portions 11 and 12 of the body members *a* and *a′* are straight, as is shown in Figs. 1 and 3, and a pin 13 is secured to the fixed member *a* of the body, being adapted to pass freely through an aperture 14 in the pivoted or swing member *a′* when the two members are brought together in working position.

A dotting disk or wheel is adapted to turn freely on the pin 13, and between the terminal portions 11 and 12 of the aforesaid body members *a* and *a'*. These body members are adjusted to and from each other and are held in adjusted position by means of an adjusting or set screw 16, which is preferably loosely passed through the swing or pivoted member *a'*, the threaded portion of the screw entering a threaded aperture in the fixed or stationary member *a*, as is best shown in Fig. 3.

At the upper portion of the body A a second pin 17 is secured to the fixed member *a*; but this pin 17 stops short of the swing or pivoted member *a'* when the latter is closed, as is shown in Figs. 1 and 3. This auxiliary or second pin 17 is adapted to carry supplemental dotting disks or wheels 18, the said dotting disks or wheels being provided with peripheral teeth of different sizes, so as to produce different lengths of dots on the paper or surface over which the disks or wheels are to travel.

The device for feeding ink to the

Fig. 1,

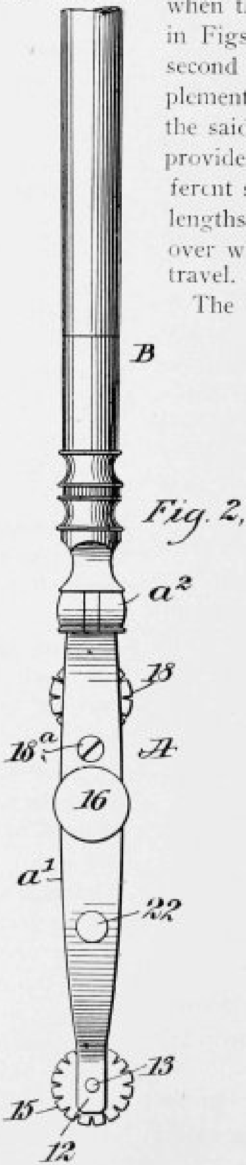


Fig. 2,

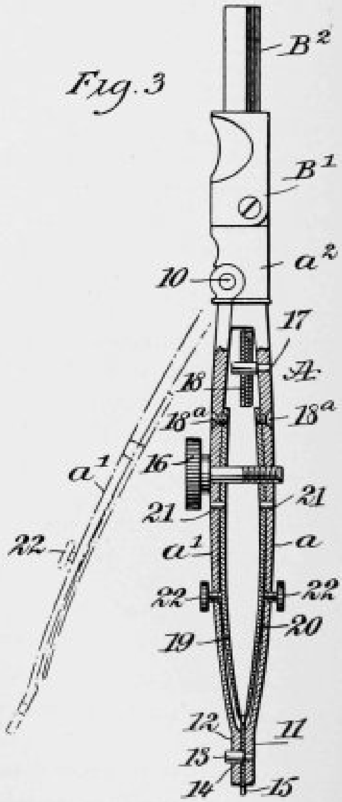


Fig. 3

dotting disk or wheel in action comprises two members 19 and 20, preferably made of spring steel and oppositely bowed or curved, following practically the lines of the inner faces of the body members *a* and *a'*. The upper ends of the members 19 and 20 of the ink-feeding device are secured to the members *a* and *a* of the body by suitable screws 18*a*, located above the adjusting-screw 16 for the body, and below the said adjusting-screw 16 guide-pins 21 are secured to the body members *a* and *a'*, passing through suitable openings in the members 19 and 20 of the ink-feeding device. The said members of the ink-feeding device are also provided with suitable apertures through which the stem of the adjusting-screw 16 of the body may freely pass. The lower ends or extremities of the members of the ink-feeding device are made to converge more or less and are adapted to normally have a position one at each side of the toothed peripheral surface of the dotting disk or wheel in action, as is shown in Figs. 1 and 3.

The ink is fed to the ink-feeding device by means of an ordinary pen or a feeder usually contained in bottles of liquid ink in the same manner as the point of an ordinary drawing-pen is fed, and the volume of ink thus placed between the members of the feed device, as is shown in Fig. 1, is constantly in engagement with the periphery of the dotting wheel or disk, so that the said dotting wheel or disk, as the pen is operated, will not make a miss.

The amount of ink to be fed to the dotting wheel or disk in action is regulated through the medium of regulating or adjusting screws 22, one of which is provided for each member or jaw 19 and 20 of the ink-feeding device. These adjusting or regulating screws 22 are passed through threaded apertures in the body members *a* and *a'* of the pen and have engagement at their inner ends with the outer faces of the members or jaws 19 and 20 of the ink-feeding device. Thus it will be observed that the adjustment of the pen in its entirety is completely under the control of the operator and that the pivoted or swing member *a'* of the body may be carried away from the fixed member *a* whenever it is desired to clean the pen or to change the dotting disk or wheel.

This pen is perfectly adapted for the purpose intended. It is readily cleaned, and the supply of ink to the dotting disk or wheel will be constant, and ink can be supplied to the feeding device as readily as ink can be supplied to the working points of an ordinary drawing-pen.

CHANGES.

The Cleveland Engineering Agency has opened an office at 1065 The Rose Bldg., Cleveland, O., where applications will be received.

Mr. G. W. Spellman, formerly of this city and for some time with the Engineering Department of Zion City, Ill., has been unanimously appointed by the council to the office of City Engineer of that growing center of industry.

A copy of Tables and Other Data for engineers and business men, compiled by Charles E. Ferris, B. S., of the University of Tennessee, has come to hand.

It is the fourth edition of this neat little book and is full of good things. Leather bound, 24 pages, gilt edges, price 50c. Published by the University of Tennessee, Knoxville, Tenn.

Beam Compass.

Nathaniel B. Stone, residing at Outlook, Washington, has invented a useful improvement in beam-compasses.

The object of this invention is to provide a beam-compass the back edge and sides whereof shall be left free and unincumbered, thereby permitting the use of said back edge for a straight-edge and leaving the scale on the sides uncovered from end to end of the beam at all times, all as will be hereinafter more fully described and claimed.

Referring to the accompanying drawings, which are made a part hereof, and on which similar reference characters indicate similar parts, Figure 1 is a side elevation of a beam-compass embodying said invention; Fig. 2, an under side plan of the same; Fig. 3, a cross-section on the dotted line 3 3 in Fig. 1; Fig. 4, a similar section on the dotted line 4 4; Fig. 5, a view looking downwardly from dotted lines 5 5 in Figs. 3 and 4, the beam being indicated by dotted lines; and Fig. 6, a view of a modified form.

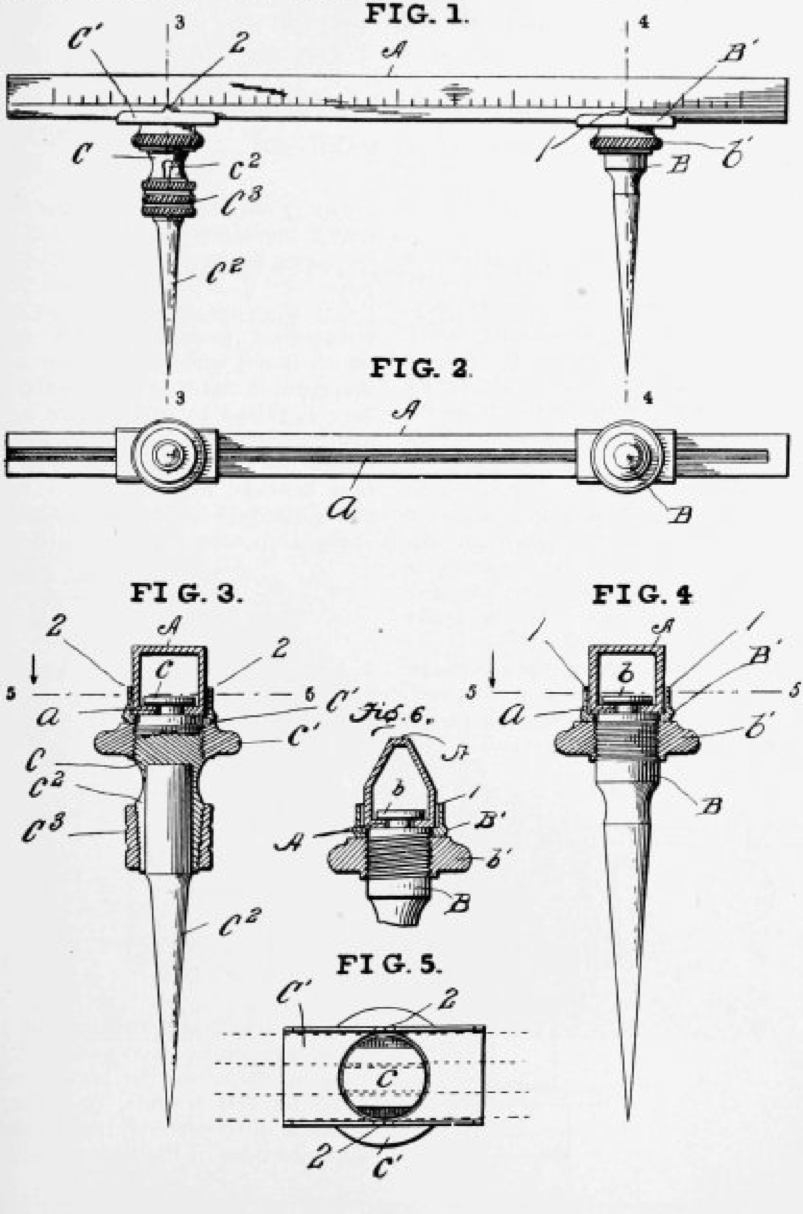
In said drawings the portion marked A represents the beam, B one of the points, and C a socket for containing the other point.

The beam A is of a rectangular form, preferably hollow, and is formed with a central groove or slot in its front face. Its back edge is straight to adapt it for use as a straight-edge, and a graduated scale is formed on one or both of its side faces by which the position of the points may be accurately and easily determined.

The point B is formed with a head *b* on its base and with a groove on each side near said head to form a neck which will slide readily in a slot or groove *a* in the front face of the beam. Near its base said point is formed screw-threaded and has a nut *b'* on said screw-threaded portion. A flanged plate B′ is mounted to slide on the face of said beam and contains a central aperture of a size to receive the base end of point B. Indicating-points 1 are formed in the center of the flanges of said plate, said points being exactly in line with the center of point B. Said plate B′ is mounted on the end of point B, the head *b* extending through said plate. Said head is then slid into the slot *a* of the beam and adjusted to the position desired on said beam. The plate is then securely locked in said position by tightening the nut *b'*, which draws the head against the inner face of the beam, as will be readily understood. When it is desired to move said point, the nut *b'* is loosened and the point slid to the desired position, and then said nut is again tightened, thus securing said point in any position very quickly and easily, as will be readily seen.

The socket C is formed at its base similar to the construction of the base of point B and has a head *c*, a nut *c'*, and a flanged plate C′, having indicating-points 2, arranged and operating exactly as described for the corresponding parts shown in Fig. 4. The outer end of said socket is formed to contain a point C^2, being slotted on one side at c^2 and formed tapered and screw-threaded at its outer end, with a nut C^3 mounted thereon, by which said point C^2 may be locked in place. Said point C^2 may thus be interchanged with other points of ordinary construction when desired.

Instead of a beam of rectangular formation one formed tapered on its sides from back of the flanges of plates B′ and C′, as shown in Fig. 6, may be used if preferred. The angle of taper is such that the sides of the nuts will support the instrument when used as a straight-edge.



QUESTIONS AND ANSWERS.

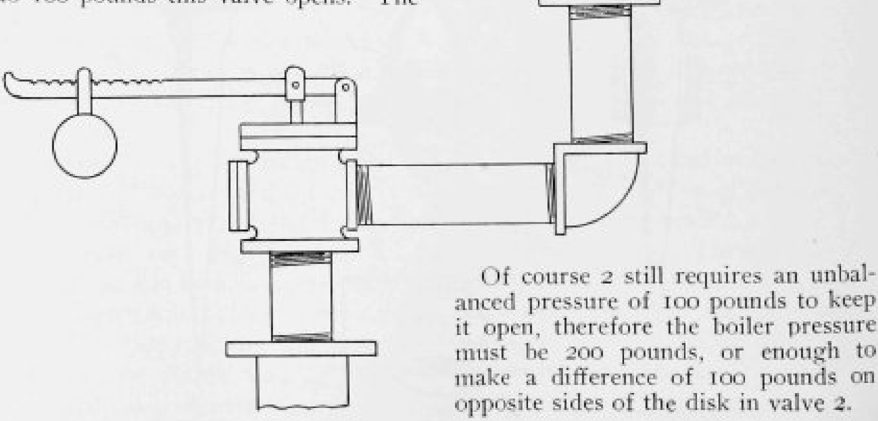
Pressure Required to open safety Valve.

BY W. H. WAKEMAN.

Editor The Draftsman:—

In the accompanying sketch, 2 represents an ordinary lever safety valve set to open at 100 pounds pressure in the boiler. 3 is another safety valve of the same type set to open at 100 pounds, and attached to the outlet of 2 as shown. What boiler pressure will be required to open 3 under given conditions?

A. When a safety valve is set to open at 100 pounds pressure, it means that the disk will lift when an unbalanced pressure of 100 pounds is applied to it. Suppose that a pressure of 98 pounds is raised on the boiler directly under 2, while there is no pressure by the gage in pipes between 2 and 3. The valve 2 is still closed, but as soon as boiler pressure is raised to 100 pounds this valve opens. The escaping steam does not find a free outlet, therefore pressure begins to accumulate in the discharge pipe. Suppose that it is 2 pounds here, while boiler pressure remains at 100. The unbalanced pressure is 98 pounds, which is not sufficient to keep 2 open, therefore it closes. When boiler pressure is raised to 102 pounds 2 opens again, discharges as before and continues the operation until pressure in pipe between the two valves reaches 190 pounds when 3 opens and discharges into the atmosphere.



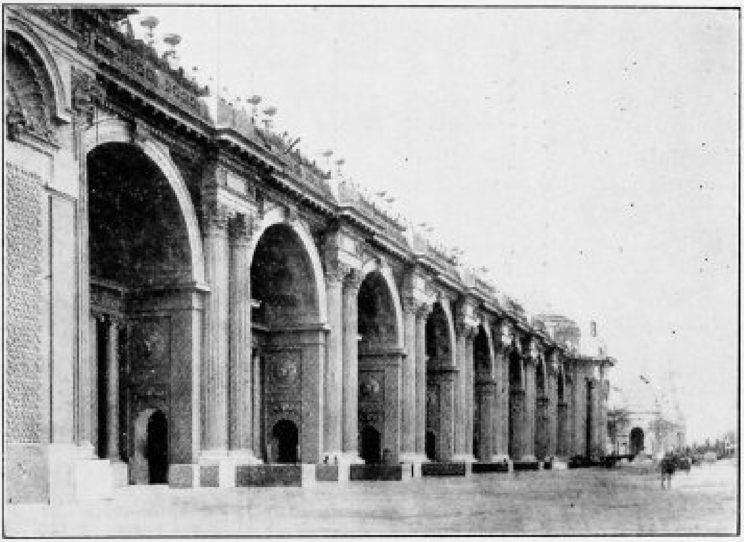
Of course 2 still requires an unbalanced pressure of 100 pounds to keep it open, therefore the boiler pressure must be 200 pounds, or enough to make a difference of 100 pounds on opposite sides of the disk in valve 2.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Manufacturers Bldg. World's Fair.



MECHANICAL.

Problems in Beams and Planes Severally Supported and Eccentrically Loaded.

C. F. Blake.

Among the troublesome problems that sometimes occur to the designer are the cases of beams carryng a concentrated load, or loads, and borne upon several supports, the reaction upon these supports being required. Such problems, however, may be easily solved by an application of the principles of the polar moment of inertia. Attention has already been called by the writer to the advantages of the application of these principles to the design of riveted joints, but as the usefulness of the polar moment of inertia method is not as well recognized as it should be, a few remarks upon its use in general may not be out of place before appyling the method to the problems in hand.

The general formula for equilibrium under the polar system of co-ordinates is the same as that for the rectangular system with the subscript *p* added to the proper quantities to denote that they refer to the polar system.

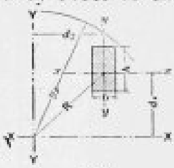


Fig. 1

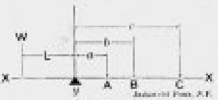


Fig. 2.

$$M = f\frac{I_p}{y_p} = f Z_p \text{ ....(1)}$$

M = the moment about the pole in inch-pounds.
f = the fiber stress upon the most remote fiber from the pole.
y_p = the distance from the pole to the most remote fiber.
I_p = the polar moment of inertia.
Z_p = the polar section modulus.

If, when considering the torsional resistance of any section about a given pole, we draw through that pole a system of rectangular co-ordinates, co-ordinate moments of inertia of the XX and YY, the polar moment of inertia of the section will be the sum of the two co-ordinate moments of inertia about these axes. Thus, referring to Fig. 1, let Ix and Iy be the section about the x and y axes respectively, these axes being drawn through the center of gravity of the section. Then from the well-known formula, the moments of inertia about the axes

XX and YY respectively, are:

$$\left.\begin{array}{l} I_X = I_x + A d_1^2 \\ I_Y = I_y + A d_2^2 \end{array}\right\} \text{ where } A = \text{the area of the section.}$$

Then, $$I_p = I_X + I_Y = I_x + I_y + A R^2$$

Where several sections are grouped about a pole, the total moment of the group is the sum of the several polar moments taken separately as above for each secton.

Thus for any number of sections,

$I_p = \Sigma\ (_x + I_y + AR^2)$ 2

and substituting this valve in (1) we have,

$$M = f\frac{\Sigma\ (I_x + I_y + A\ R^2)}{y_p} \text{ ....(3)}$$

$$Z_p = \frac{\Sigma\ (I_x + I_y + A\ R^2)}{y_p} \text{ ....(4)}$$

At present we are dealing with loaded points instead of sections, so Ix, Iy, and A approach zero, and (4) reduces to

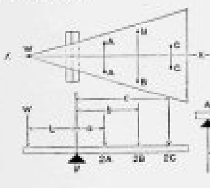
$$Z_p = \frac{\Sigma A R^2}{y_p} \text{ approximately} \ldots\ldots\ldots\ldots (5)$$

From this we see that the torque set up by the reaction of a point is directly proportional to the square of its distance from the axis of rotation, and it is this fact upon which the following solutions depend.

In Fig. 2 let XX be a beam supported at y, loaded by a known load W at a distance L from this support, and prevented from rotating about y by the reaction of several points, A, B and C, distant respectively a, b, and c from the support. Required the reactions A, B and C. The torques of the reactions at the several points on the right of the support are proportional to the squares of their distance from y, therefore the total torque on the right of y is proportional to $(a^2 + b^2 + c^2)$, and the torque obtained from reaction WL, on the left of y.

$$\left.\begin{array}{l} A = \dfrac{a^2}{a^2 + b^2 + c^2} \\ B = \dfrac{b^2}{a^2 + b^2 + c^2} \\ C = \dfrac{c^2}{a^2 + b^2 + c^2} \end{array}\right\} \text{ of the total torque.}$$

Since a force exerting torque about an axle is equal to the torque divided by the arm at which it acts, we have the force



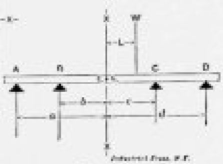


Fig. 3. Fig. 4.

$$A = \frac{\dfrac{a^2}{(a^2 + b^2 + c^2)} W L}{a} = \frac{W L a}{a^2 + b^2 + c^2} \ldots\ldots (6)$$

Likewise the force

$$B = \frac{W L b}{a^2 + b^2 + c^2} \ldots\ldots\ldots\ldots (7)$$

and

$$C = \frac{W L c}{a^2 + b^2 + c^2} \ldots\ldots\ldots\ldots (8)$$

Thus, having the values of W, L, a, b, and c, we arrive at values for A, B, and C such that, acting through their respective arms a, b, and c, they will balance the force W acting through its arm L.

Having found the values of A, B, and C, the force upon the support y is

$$W + A + B + C.$$

This is applicable no matter how many points of reaction there may be, nor how they are placed, so long as they are symmetrical about a line drawn through W. This is shown in Fig. 3, which represents a plane balanced upon a knife edge, having a load W on the left, and several points of reaction on the right, these points being symmetrically placed about the line $x\,x$. This problem may be treated exactly as that shown in Fig. 2, the resulting load upon the knife edge being uniformly distributed.

If the points are not symmetrical about $x\,x$, the same method may be used, but the resulting load upon the knife edge will not be uniformly distributed. Fig. 4 represents a beam severally supported at A, B, C, and D, and loaded at W. The line $x\,x$ is drawn through the center of gravity of the supports A, B, C, and D. The reaction of each support due to the torque WL is found by formula (6). Note must be made of the directions of these reactions; in Fig. 4 the load W would, in the absence of the supports, rotate the beam clock-wise about the center of gravity, hence the forces A and B are up, and the forces C and D are down. In algebraic addition to these loads at the several supports, each support will have a vertical load down of $\frac{W}{n}$ pounds, where n is the number of supports.

Thus in Fig. 4 the load at A is

$$A = \frac{W}{n} - \frac{W L a}{a^2 + b^2 + c^2 + d^2} \quad \ldots\ldots\ldots (9)$$

and the load at C is

$$C = \frac{W}{n} + \frac{W L c}{a^2 + b^2 + c^2 + d^2} \quad \ldots\ldots (10)$$

etc., n being 4 in the case of Fig. 4.

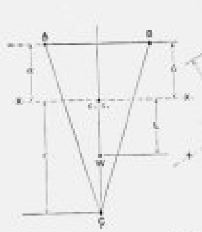


Fig. 5.

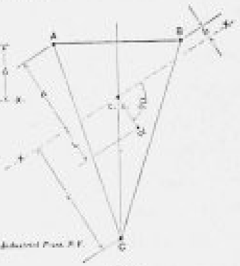


Fig. 6.

Let Fig. 5 represent a plane severally supported at A, B, and C, and loaded at W; required the reactions at the supports. Locate the axis of rotation $x\ x$ through the center of gravity of the supports. Each support resists a down load of $\frac{W}{n}$, and at the same time a load due to the torque of WL about the axis of rotation $x\ x$, precisely as in Fig. 4, and the same formula (9) may be used.

Fig. 6 is the same as Fig. 5, except the load is not symmetrically placed as regards the supports. Locate the center of gravity of the supports, and connect this with the point of loading W. Through the center of gravity perpendicular to this line draw the axis of rotation $x\ x$. From each point of support drop a perpendicular to $x\ x$, thus getting the arms at which the reactions act. The reactions at the supports may now be obtained by formula (9). The method of Fig. 6 is applicable to any plane severally supported and loaded, since W may represent the center of gravity of any number of known loads upon the plane, and the formula may be extended for any number of supports.

A graphical solution for formula (9) sometimes convenient is as follows: In Fig. 7 draw the rectangular axes xx and yy, and and lay off a unit of the selected scale on xx. Also on xx lay off the arms at which the reactions act, a, b, and c, obtaining points A, B, and C. At these points erect perpendiculars, and also through these points pass arcs $A1$, $B3$ and $C5$, with o as center. Through the points 1, 3, 5, where these arcs cut the perpendicular from the unit point, pass radial lines from o, and extend them to meet the respective perpendicular from A, B, and C at points 2, 4, and 6 respectively. Then

$$\frac{o\ 1}{\text{unit}} = \frac{o\ 2}{o\ A}$$

and since the unit equals 1, and $oA = o1 = a$, we have

$$\frac{a}{1} = \frac{o\ 2}{a},\ o\ 2 = a^2.$$

Likewise $o4 = b^2$ and $o6 = c^2$. With a radius equal to L, describe an arc cutting the unit perpendicular at 7, and draw a radical line through this point to cut lines from A, B, and C in 8, 9, and 10. Then $o8 = La$, $o9 = Lb$, and $o10 = Lc$.

Having found the lines representing a^2, b^2 and c^2, set the dividers to a radius equal to the sum of these lines, and with an arc cut the unit perpendicular at H. Draw oH. Transfer points 8, 9, and 10 to 8′, 9′, and 10′ on line oH by means of arcs struck from o, and from the latter points drop perperpendiculars. The distances a', b', and c', when measured to the adopted

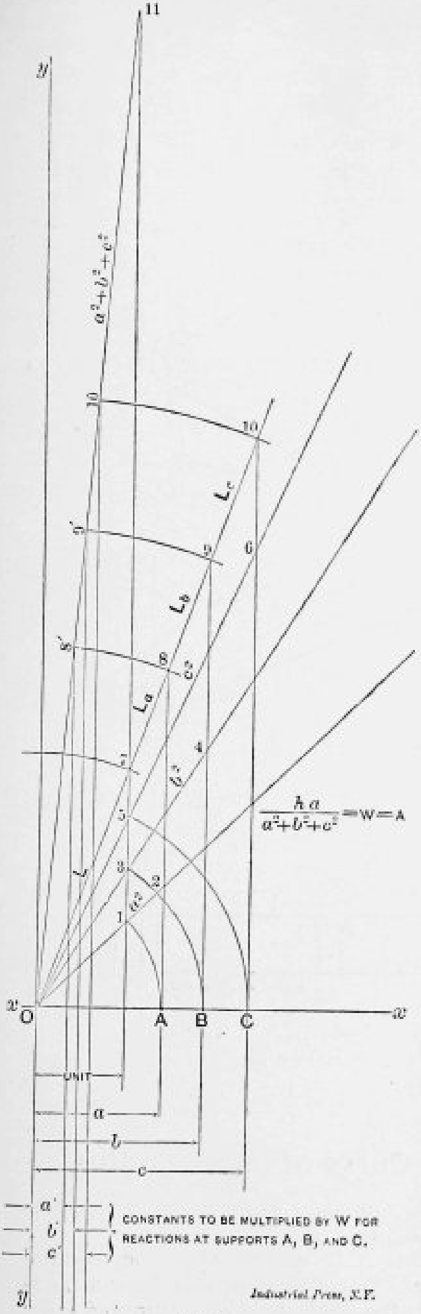


Fig. 7.

scale, and multiplied by W give the reactions at A, B, and C respectively.

Like the formula, this diagram may be extended to cover any number of points of reaction. As in all written descriptions of graphical methods, the actual work required is far short of what seems necessary when first read, and is in reality very simple. The range of problems to which this method is applicable is very great, including the loads carried by machinery foundations, car loadings, beams, anchor plates, and many intricate details of machine design, in short any problem, no matter how intricate, that may be reduced to a plane supported upon several points, and carrying one or more loads, the center of gravity of which is known. The following problem will serve as an illustration:

Fig. 8 represents a four-legged spider or anchor plate, loaded as shown; the arms being of varying lengths we require the reaction at each support, in order to proportion the arm sections.

Draw $B\ C$ and bisect it at e, also bisect $A\ D$ at f. Join e and f, and bisect ef at g. Then g is the center of gravity of the supports A, B, C, and D if the load on each one is unity. Draw $o\ g$, and $x\ x$ perpendicular thereto, and upon $x\ x$ drop perpendiculars from A, B, C, and D.

We then have from formula (6),

$$\text{Load at } A = \frac{1000 \times 1.75 \times 10.5}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 71.9 \text{ lbs. downward.}$$

$$\text{Load at } B = \frac{1000 \times 1.75 \times 3.25}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 22.14 \text{ lbs. downward.}$$

$$\text{Load at } C = \frac{1000 \times 1.75 \times 11}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 73.35 \text{ lbs. upwards.}$$

$$\text{Load at } D = \frac{1000 \times 1.75 \times 3.75}{(10.5^2 + 3.25^2 + 11^2 + 3.75^2)} = 25.62 \text{ lbs. upwards.}$$

1000 lbs. × 1.75 inch lbs. = 1750 inch lbs.

71.9 × 10.5 = 754.95 inch lbs.
22.14 × 3.25 = 71.955
75.35 × 11 = 828.850
25.63 × 3.75 = 96.112
1751.867 inch lbs. check

$$\text{Vertical load on each arm} = \frac{1000}{4} = 250 \text{ lbs. downward}$$

Resultant on $A = 250 + 71.9 = 321.9$
" " $B = 250 + 22.14 = 272.14$
" " $C = 250 - 75.35 = 274.65$
" " $D = 250 - 25.63 = 224.37$
1098.06 lbs. check.

The error, less than ten per cent, arises from dropping decimals in taking squares, and from slide rule readings, but the check is as close as practice demands.

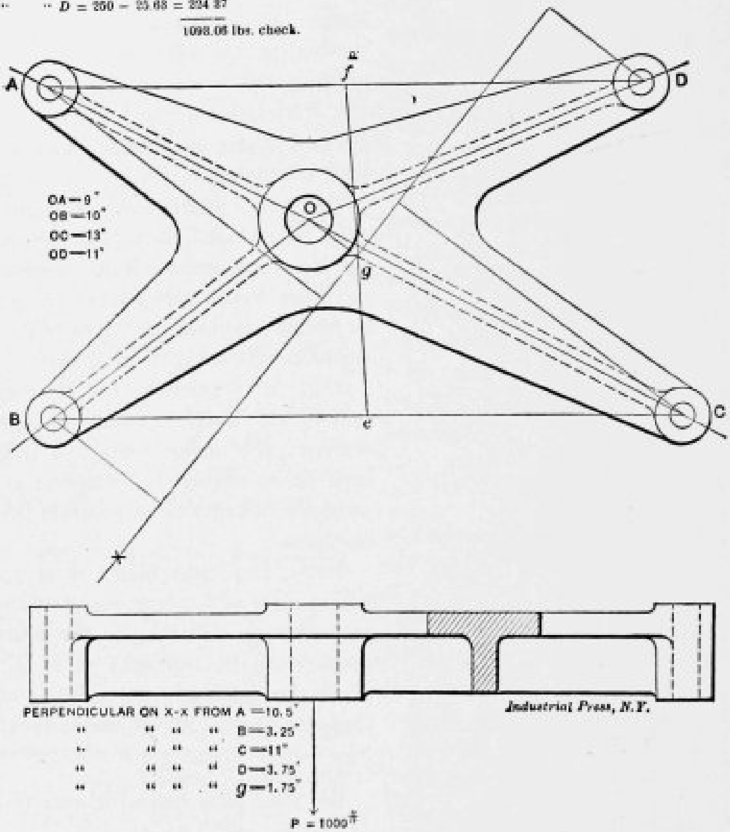
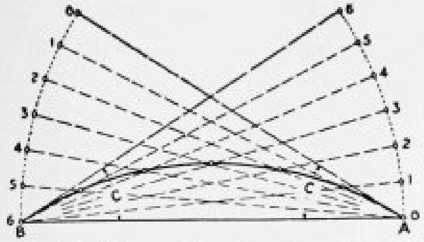


Fig. 8.

A Neat Method of Plottinga Curve of Large Radius.

A writer to *Engineering News* says, "Sir: The recent publication of several methods of drawing the parabola leads me to send you this note on the circle. Experience in the drawing-room shows that draftsmen are often puzzled as to the means of drawing a circular arc of radius too large for the beam compass or a "railroad" curve. The following method has proven satisfactory.

Let A B be a chord of the required arc. At each end of this draw a tangent, the angle C being computed from the formula $\sin C = \frac{\frac{1}{2}\text{ chord}}{\text{Radius}}$; from A and B as centers drawn arcs BO



and A6, intersecting the tangents; divide these arcs into any number of equal parts and number them in reverse order, as shown; draw the series of radial lines from A and B. The intersection of A1 with B1 will give a point on the required arc, as will also that of A2 with B2, and so on for the other pairs of radii. A spline or a steel straight-edge (placed edgewise to the paper) may then be sprung so as to pass through the points, and the curve drawn along the edge.

Very truly yours,
Frank T. Daniels,
No. 1 Ashburton Place.

Tooth Gearing, The Elliptic Gear.

The principal and almost the only use of the irregular gear is to produce a variation of speed between given limits without conditions as to the variations of speed between these limits being known.

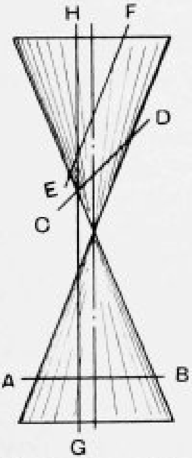


Fig. 1

When this is the only object, the elliptic pitch line is the only one that is required and it is chosen because it is the only known continuous closed curve that will work in rolling contact with an equal mate.

Next to the circle it is the simplest known curve and when used is arranged to revolve on one of its foci as a center.

The use of the elliptic gear is practically confined to producing a simple variation of speed between known limits and to produce a "quick return motion" for planers, shapers, slotters, shears, punches, shingle machines and others where the work is done mostly during one half of the stroke of a reciprocating part.

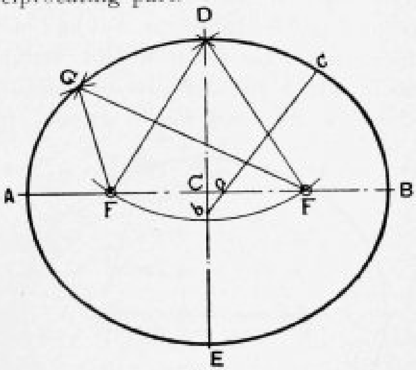


Fig2.

A definition of the elliptic is that it is one of the "conic sections." If a cone Fig. 1 is cut by a plane A B at right angles with its axis, the outline of the section will be a circle.

If the plane CD cut the cone at an angle, the section is an ellipse. If the plane EF is parallel with a side of the cone, the section is a parabola and if the plane GH is at such an angle that it cuts both nappes of the cone, the section is a hyperbola. All the curves will roll together when fixed on centers at certain points called foci but the ellipse and the circle are the only ones that permit of continuous motion.

In the ellipse Fig. 2 the point C is the center, the longest diameter AB is the *major* axis, the shortest diameter DE is the *minor* axis; A and B are the major apices and E and D are the minor apices.

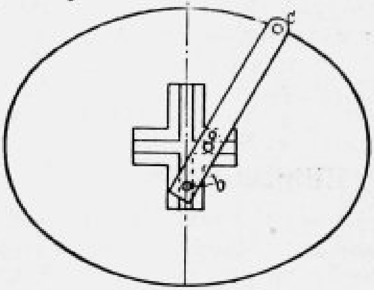


Fig. 3.

An arc drawn from the minor apex with a radius equal to half the major axis will cut the major axis at the point F and F' called the foci and one focus must be taken as the center about which the curve is to revolve, if used as the putch line of a gear.

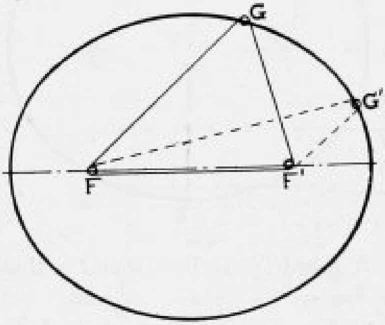


Fig. 4.

It is a characteristic of this curve that the sum of the distance GF and GF' from any point G to the foci is equal to the major axis AB and this is used as a means of constructing the curve by points.

Draw an arc from one foci with a radius FG, then subtract its length from AB and the remainder will be the length of line F'G. Hence it will be readily seen that if only AB is known and the location of F and F' and F'D are equal and each one half of AB, thus giving the length DE.

Another valuable property of the ellipse is that if the line bac is so drawn that the distance ca is equal to Ce and cb to Ac, the point c will be upon the curve if the points a and b are upon the axis.

Upon this principle an instrument called a trammel is made to describe the ellipse, Fig. 3.

Other elliptographs have been tried but the simplest one consists of a couple of pins, a thread and a pencil.

The pins are inserted at the foci, as in Fig. 4 and the curve is drawn by moving the pencil with a uniform stress on the string but this method should not be relied upon when accuracy is desired.

The radius of curvature at either apex, that is, the radius of the circle that most nearly coincides with the curve is found by the following approximate method and it is quite accurate where the ratio of axes is not less than eight to ten.

Draw the major and minor axis at right angles to each other and draw the line CB, Fig. 5.

With O as a center, draw arc from C and lay off C2 on CB equal to the difference between half the major and half the minor axis.

Bisect 2B with line 34 and produce it to cut both axes. Then make O5 and O6 equal to O3 and O4 respectively and use 3, 4, 5 and 6 as the centers of the curves.

These centers will be used for

circles at point and root of the teeth and for the base circle in involute teeth.

ROLLING ELLIPSES.

When two equal ellipses Fig. 6 are arranged to revolve on their foci as centers with a center distance equal to the major axis they will roll together perfectly and can serve as the pitch lines of gears.

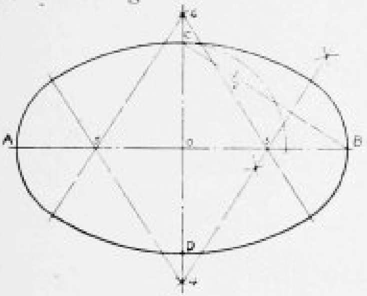


Fig. 5.

As the ellipses roll together, it is essential that the axis come in line and therefore if the teeth of one gear are fixed at random, those of the other must be placed to correspond. It is very desirable that the gears be exactly alike so that in the case of cut gears they could both be mounted together on the same arbor and one operation do for both if the number of teeth are even and they start at the same point.

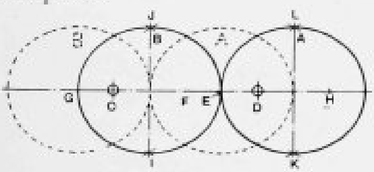


Fig. 6.

If the number is odd, the major axis must bisect a tooth and a space, and in this case the gears can be turned over or if its other foci can be used as a center, it may have a tooth from the major axis as at *a* Fig. 7.

The best way of spacing the ellipse is to step about it with the dividers. If the curve is flat, the dividers should be set slightly less than a whole tooth for equal chords will not measure equal arcs of the curve and it is suggested that some better method be obtained for mechanical purposes.

As in the case of the circular gear the form of tooth may be either cycloidal or involute, the latter being the best for the same reasons as with a circular pitch line.

The curve of the face and flank of the tooth may be laid out in accord with methods laid down for cycloidal or involute curves.

A PRACTICAL CASE.

Two ellipitical gears are to run together with a velocity of 3 to ⅓, the major axis being 8 inches.

If as in Fig. 6, the gears are placed as shown by the heavy lines, gear A will be turning three times as fast as B and B only one third as fast as A.

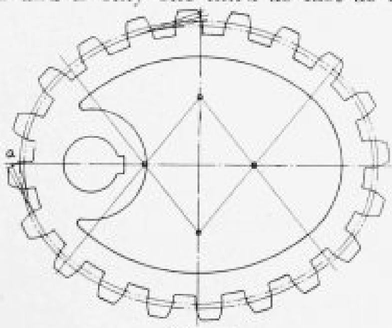


Fig. 7.

When the gears have assumed the position as indicated by the dotted lines A will be going one third as fast as in its previous position and B three times as fast as before.

Then CE will be three times as long as DE and since the distance between foci is equal to the major axis which in this case is 8", then CD will be divided into four equal parts, three for gear B and one for gear A. CE will become 6" and ED will be 2".

Draw the line for the position of the minor axis at the center of the major axis.

As stated before DL and HL are each equal to one half the major axis or in this case 4", and with compass set at H and D, strike arcs K and L with a radius of 4".

Draw a pair of ellipses with major and minor axis by means of the trammel, the string or four point circle method.

If the ratio of speed was from 4 to ¼ then the distance from center to center (C to D) would have to be divided into five parts. If 2 to 5, then DE would be 2-5 of CE.

CHILL ROLLS.

In an article, "Chill Rolls," in the *Iron Age*, Mr. B. E. V. Luty says that the standard dimensions of tinplate rolls in this country are 26 inches diameter, 32 inches long in the body and 20 inches diameter in the necks. The depth of chill is about ⅞ inch, but it was formerly only ½ to ⅝ inch. The life of a chill roll is only from 90 to 120 actual working days for tinplate or ordinary sheet rolling, running at 30 revolutions per minute. But many good rolls are broken before they are worn out. The reasons for breaking are somewhat indeterminate, although they may be included under three heads: 1. Casting strains. 2. Excessive pressure on the roll from the material being worked. 3. Heat strains produced in the roll by irregular working. While theoretically the pressure necessary to break rolls by excessive pressure is something enormous, they are frequently broken in this way. It is calculated by the formula

$$W = \frac{4f}{l} 0.0982d^3 \text{ in which}$$

W = load in pounds, applied at the center,
f = fiber strength
l = distance between supports
d = diameter
so that on a standard roll the load applied to the center necessary to break it would be 2,887,000 pounds, taking the fiber strength to be 20,000 pounds per square inch.

Shrinkage of Castings.

H. C. TULLY.

Agricultural implement shops to get better foundry fits draw cast details to single (12⅛") or double (12¼") shrink scale on heavy paper. In this way, the patternmaker gets an undimensioned picture which he does not like as it seems to reflect on his ability to have drafting rooms show him what size to make the pattern.

About 99% of the drawings are 12¼" scale as an implement foundry make short work of a wood pattern so that 12⅛" scale is only used when no metal pattern will be needed.

A new metal placed on the market by an English firm as a substitute for nickel is said to possess advantages over nickel plated goods. It is silver white through and through, and, it is claimed, keeps its brilliance permanently and will not rust under most unfavorable conditions. Malleable to a degree when cold, it is easy to solder and braze, the flux being ordinary soldering water and borax.

ELECTRICAL.

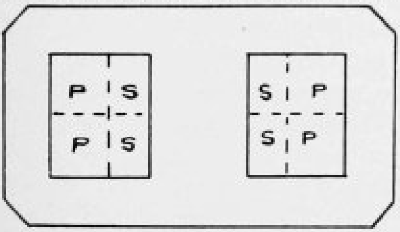
Transformer Design.

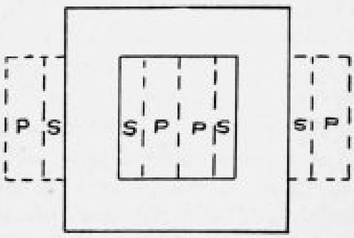
By Messers

In going about the design of a transformer, the designer must first consider the following things: (a) the capacity required; (b) the nature of the load; (c) the frequency and voltage.

(a) A transformer in nearly all cases, is designed to take care of the maximum demand that may be made upon it. This maximum load, in lighting transformers, comes but once a day and is often of but a few hours duration. For the remainder of the 24 hours the transformer operates either at no load or at a small fraction of full load capacity.

Under (b) the nature of the load, several things must be considered in designing the transformer. Is the load to be power or lighting—for constant or for infrequent service. If the transformer is to be used for power service, small fluctuations in secondary voltage, due to fluctuations in the load, are not of so much importance as they are in the case of a lighting load. In the latter case a 2 per cent variation of voltage is quite noticeable. So for lighting transformers a comparatively good regulation is required. The drop of secondary voltage with increase of load on the transformer is caused by the increased IR drop in both the primary and the secondary winding. Thus for good regulation the transformer winding must be of low resistance; that is we must use a large weight of copper, increasing the cost of the transformer. For power service, where good regulation is not so essential as in lighting, the coils may be wound of smaller wire, and thus at a lower cost.





The actual values for the regulation found in modern transformers vary from 2.75 per cent in the small sizes to 1.9 per cent in the large sizes. The designer must also know whether the transformer is to be used but a few hours per day or whether it is to be used on an all day load. Since the core losses of a transformer continue whether there is a load on the secondary or not, when a transformer is used but a few hours each day, the core loss may represent quite a large part of the total energy. Thus for infrequent service a transformer designed with a low core loss is the only acceptable one. Its copper losses on the other hand may be quite high since they cease as soon as the load is taken off.

(c) The voltage and frequency at which the transformer is to be used are also important matters in its design. The ratio of the voltages of the primary and secondary determines the ratio of the primary and secondary turns, while the greatest difference of potential connected with the transformer determines the insulation necessary. The frequency, has a large influence on the size of the transformer and its core losses.

We will now suppose that the designer has investigated all of the conditions mentioned above and is ready to proceed with his calculations. He may choose one of two general classes of design: First, the shell type of transformer having a divided magnetic circuit in which the iron is placed around the coils as shown in Fig 1, or second, the core type having but a single magnetic circuit, and having an iron core inside of the winding as shown in Fig. 2. The first mentioned class contains more iron and consequently presents a greater radiating surface. This means that with the same loss of energy, the shell type transformer will operate with a less increase of temperature than the core type. On the other hand, the core type, containing less iron, will operate with a smaller loss of energy due to hysteresis and eddy currents since these losses increase directly with the volume of the iron.

Having chosen the type of transformer, the designer is now ready to proceed with his calculations. He must keep the following points in mind: The efficiencies, the regulation, heating, insulation, and cost. The conditions known are, the ratio of transformation, the character of the work for which the transformer is to be used, the frequency and voltage at which it is to operate, and the capacity required.

The first thing to be determined is the total magnetic flux, or the total number of lines of force in the magnetic circuit.

Assume T = number of turns in the primary in series. Then the flux

The designer must now choose the flux density or number of lines of force per sq. in. = B. He does this by inspecting a table giving values for B corresponding to different conditions of service.

Having decided on the value of B, the cross section area of the magnetic circuit A = is determined. He may now lay out this section.

Since the ratio of transformation is known, the number of turns of wire in the secondary is obtained.

The current density at full load must now be chosen. This will vary in value between 1000 and 2000 C. M. per ampere, depending on the specifications for the transformer. In any case the current density chosen should be such that the heat distribution shall be the same throughout the two coils. Knowing the current density the size of wire to be used in winding both primary and secondary coils is obtained from a wire table and the space occupied by the coils calculated.

The designer can now calculate the length of the magnetic circuit and the volume of iron to be used; he may also decide on the shape and thickness of the stampings, allowance being made for proper insulation and ventilation. This being done the core loss due to hysteresis may be determined as follows:

The loss from eddy currents is calculated in the following manner:

The total iron loss will, of course, be the sum of these two losses, or,

In order to calculate the efficiency, the total loss in the transformer must be known. This, in addition to the iron losses, includes the I_2R losses in both primary and secondary.

where K = capacity of the transformer in watts. The all day efficiency of the transformer is very important. In order to calculate the all day efficiency, the designer must know the number of hours each day that the transformer is used. The iron loss will be constant, being independent of the load, but the copper loss will depend directly on the amount of power used.

The all day efficiency will be the ratio of the watt hours taken out of the transformer to the ratio of the watt hours supplied to the transformer for a period of 24 hours.

In order to determine the regulation or drop at full load, the designer must know the drop in both primary and secondary, the drop in the primary being reduced to the secondary by dividing by the ratio of transformation.

This formula does not take into account the leakage drop, which is so small that it may be neglected without introducing any appreciable error.

If the transformer is to be of the self cooling type the heating is taken care of by designing the transformer case so as to present a sufficient radiating surface. It is ordinary practice to allow about 4 sq. in. of surface per watt radiated. Since all the losses of the transformer appear as heat, the minimum value for the radiating surface of the transformer in sq. in. = (core loss + copper loss)4.

The values for efficiency, regulation and heating thus found must check with the values given in the transformer specifications. Otherwise the designer will have to readjust his assumptions until he has obtained the required result.

Electric Furnace Perfected

Practical laboratory work in chemistry will be revolutionized, it is believed, by an electric furnace just perfected by Prof. Harmon V. Morse, professor of analytical chemistry at Johns Hopkins university and adjunct director of the chemical laboratory. The furnace is the result of long and hard work on the part of Prof. Morse, and his invention is one of the important scientific achievements of the year.

Prof. Morse's furnace was shown before the chemical seminary at a recent meeting of the university. He and his young assistant, Dr. J. C. W. Frazer, were congratulated by President Remsen and the scientific faculty, to whom he spoke for an hour about the apparatus.

Heretofore gas has been the only source of heat for experimental work in the chemical laboratory. For a long time scientists have been trying to devise some sort of economical electric heater. That satisfactiory results may be obtained in the heating necessary in laboratory practice four conditions must be satisfied: (1) The heat must be developed economically; (2) it must be possible to obtain definite temperatures; (3) it must be possible to maintain constant temperatures for long periods; (4) products of combustion must not be allowed to come in contact with the substances heated.

Chemists have long since seen that the solution of this problem was to be found in the electric current, which yields no products of combustion and can be developed at a constant and regular rate. Thus far, however, no one had been able to make it a practical substitute for gas.

Prof. Morse's electric heater comprises first, an ordinary copper oven incased in a box, doubly lined with an air space between, the whole covered with aluminium paint, which is not affected by high temperatures, is a poor heat radiator, and preserves the asbestos from shredding. This arrangement practically prevents any loss of heat by radiation.

The source of heat is in the stove placed within the copper oven. The stove is constructed of parallel slabs of soapstone coated with graphite, the soapstone being unaffected by heat. The graphite is evenly distributed over the slabs of soapstone, that the heat may be developed uniformly over the surface. The use of soapstone in constructing the heater is the key to the apparatus.

The electric furnace has been found to work admirably, and can be operated at a cost of less than 1 cent a day. A constant temperature of 150 degrees can be obtained for eight hours at a cost of three-fourths of a cent. It is probable that Prof. Morse's furnace will displace the old gas furnaces now in general use, and it is certain that it will add much to the exactness with which chemical processes may be carried out.

After long controversy as to the merits of the steam turbine the navy will soon install its first engine of this pattern in the Charleston navy yard at Boston, to supply power and light about the yards and to such ships in the docks as require an electric current.

POWER PLANTS OF SPAIN.

It is estimated that there are at the present time in Spain over 1,000 works generating electric current for lighting and power, and that over 2,000 generating sets are installed. Many of the companies working these electricity undertakings are using water power. Two of the companies established in Bilbao are now engaged endeavoring to utilize 20,000 horse power from neighboring waterfalls for the town supply. This is in addition to the steam plant used by five companies already engaged in supplying electric current.

ARCHITECTURAL.

A System For The Architect.

How the drawings and prints may be filed and indexed for ready reference, and how a record may be kept of material that is loaned.

BY ANNA WALTERS.

For an architect's office in a city with a population ranging from 10,000 to 50,000 the following system has been found to fill all requirements:

The plans are first classified under the headings of residences, schools, stores and offices and public buildings, according to the architect's desire. The residences are then numbered consecutively, from 1 up, as found necessary; the schools from 500 up, stores from 1,000 up, and so forth. The residences are placed in drawers marked 1, 2, 3, 4, and so on; the schools in drawers marked 5, 6, 7, 8 and 9; the stores in drawers marked 10, 11, 12, and so on.

The plans are placed in heavy manila paper envelopes of uniform size, 16 x 24 inches for residences and 20 x 30 inches for schools and larger buildings. These sizes will accommodate, without folding, almost any set of drawings made in the quarter scale. On the upper left-hand corner of each envelope is placed the drawer number, serial number and the name of the client.

These envelopes keep the plans from all dust and manifold handling, hence it is impossible for any one plan or set of drawings to become confused with another.

For the purpose of indexing these drawings, a card index is the easiest and most satisfactory. The guide cards bear the headings, residences, schools, stores, and whatever else the architect desires to list. Under each of these headings is an alphabetical index, arranged according to the names of the clients. On these cards any amount of information about each set of plans may be placed, according to the will of the user. If, for example, the architect wants to find the residence of "Wm. Green," he will look under the heading residences, and under the letter "G" find the name Green. The drawer and serial number are seen at a glance, 4 and 200. The envelope, 200, may be easily removed from the drawer, although it be at the bottom, without disarranging any other plan or set of plans.

In this way many plans may be filed away in a small space.

The following short-cut will be found very satisfactory in keeping account of the sets of blue prints issued on any piece of work:

A small blank book (or, if desired, an extra card slipped in back of the

main card in the index may be used)
8—Draftsman—Fifner 22 22
should be ruled as shown in Figure I.

For example, four sets of blue prints are issued for the residence of William Green. East set is consecutively numbered from 1 to 4. Mr. Arnold, a contractor, comes in and wishes a set of

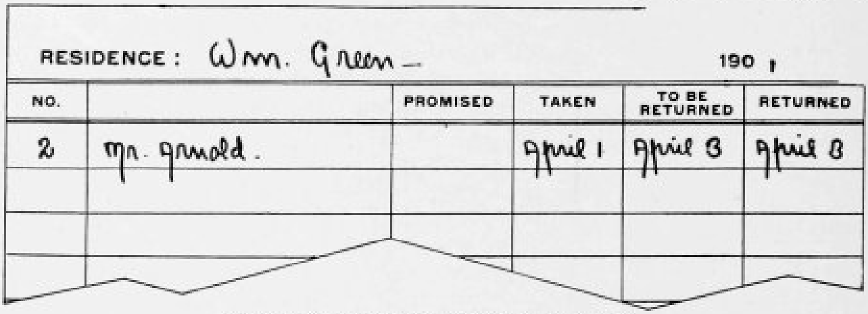


Figure I; the "follow-up" record of property loaned

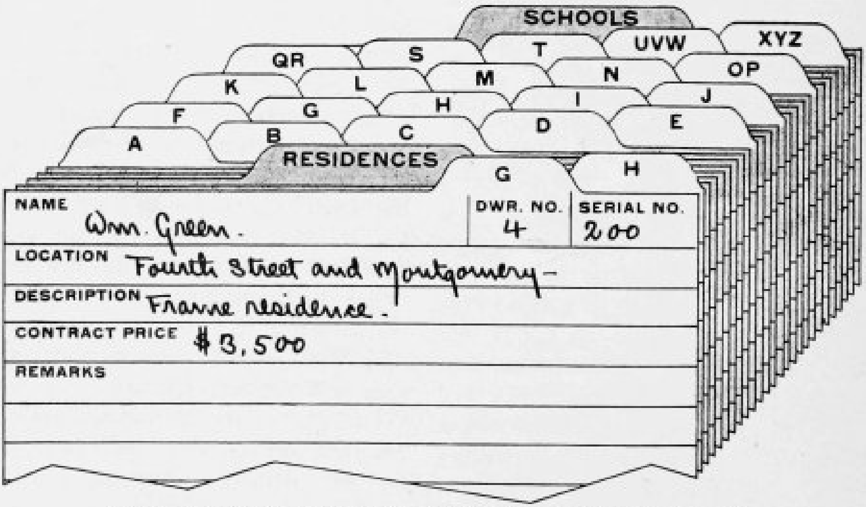


Figure II; the index for the architect's drawings, showing the arrangement of the guide

prints. His name and the number of the set given him are indicated in their respective columns, together with the date they are taken out of the office and when they are to be returned. In case there are no sets in stock, a date may be placed in the "Promised" column when there will be a set at his disposal. In this way an architect may tell at a glance where each set of blue prints is, and each set will be returned.

Often a contractor, or one who has taken a set of plans out of the office, will forget to return it, and the architect or his employe will forget to whom a particular set was given. This often causes much annoyance and loss. Under this system none of the above errors can occur.

Another short-cut for filing circulars will be found very convenient:

An architect receives daily many advertising pamphlets, circulars and business cards to which he often may want reference. By using letter files, each labeled properly, these loose cards and circulars may be kept in compact and easily accessible form. Each separate file is labeled paints, glass or hardware, as the case may be. As a circular comes in, it is placed away in the proper file, where it may be easily found when wanted.

"System."

Discolorations on Brickwork.

Trautwine gives the following excellent discussion on this subject which is of some little interest and importance both to Architects and Engineers.

The white efflorescence so common on walls, especially on those of brick, is due to the presence of soluble salts in the brick and motar. These are dissolved, and carried to the face of the wall, by rain and other moisture. Sulphate of magnesia (Epsom Salt) appears to be the most frequent cause of the disfiguration. In many places mortar lime is made from dolomite, or magnesian limestone, which often contains 30 per cent or more of magnesia; which also occurs frequently in brick clay. Coal generally contains sulphur, most frequently in combination with iron, forming the well-known "iron pyrites." The combustion of the coal, as in burning the limestone or clay, in manufacturers, in cooking, etc., converts the sulphur into sulphurous acid gas, which, when in contact with magnesia and air, as in the lime or brick kiln, or in the finished wall or chimney, becomes sulphuric acid and unites with the magnesia, forming the soluble sulphate. We are not aware of any remedy that will prevent its appearance under such circumstances; but the formation of the sulphate may be prevented by the use of limestone and brick-clay free from magnesia.

The common (not Portland) cements, when used as mortar for brickwork, often disfigure it, especially near sea coasts, and in damp climates, by white efflorescence which sometimes spread over the entire exposed face of the work, and also injure the bricks. This also occurs in stone masonry, but to a much less extent, and is confined to the mortar joints; and injures only porous stone. It is usually a hydrous carbonate of soda or of potash often containing other salts. General Gillmore recommends as a preventive to add to every 300 lbs. (1 barrel) of the cement powder, 100 lbs. of quicklime, and from 8 to 12 lbs. of any cehap animal fat. The fat to be well incorporated with the quicklime before slacking it preparatory to adding it to the cement. This addition will retard the setting, and somewhat diminish the strength of the cement. It is also said by others that linseed oil at the rate of 2 gallons to 300 lbs. of dry cement, either with or without lime, will in all exposures prevent efflorescence, but like the fat it greatly retards setting, and weakens.

Read the Want Columns, Page 10,

HOME STUDY.

Mechanics.

CHAPTER I.

In beginning the study of Mechanics, it is necessary to get an exact idea of the meaning of the terms with which it deals. Some of the expressions used here are the same as in physics, but in these lessons they will be given a somewhat more specialized meaning and the examples given below are planned to show their application in actual problems.

Mechanics is the science which treats of bodies with respect to their mutual and relative motions. Mechanics of engineering deals only with bodies that are of importance to the practice of engineering.

Matter. According to physics, whatever occupies space is called matter; in the mechanics of engineering it is the material upon which we work. For example, stone, iron, water, etc.

Mass is the quantity of matter in a body. As used by most technical writers, it is the weight divided by the acceleration of gravity, or in symbols $M = G \div g$, which is always a constant. Mass does not mean the bigness of a body as used in the popular sense, neither is it the weight as will be seen by the formula. A pound of feathers is bigger than a pound of lead ordinarily, yet their masses taken at the same locality would be equal. The size of a body will vary with its temperature and the weight will vary with the location on the earth's surface, but G and g vary together for any location and the quotient M becomes constant and is for that reason a more convenient expression to use.

Volume is the bigness of a body or the amount of space occupied by it.

Weight is the pull or force exerted upon a body due to the earth's attraction. It is therefore a measure of the force of gravity.

Heaviness is the weight *per cubic unit* of a substance. It may be asked in regard to a body, "How heavy is it?" What is meant is, what is the total weight? A lump of iron may have a total weight of twenty five pounds but its heaviness or rate of weight will be about a quarter of a pound per cubic inch.

Specific Gravity is the ratio of the heaviness of any substance to that of water. The specific gravity of water is taken as unity, and that of any other substance is expressed as a decimal. Tables of the weight and specific gravity of substances can be found in the hand books of enginering.

Motion is a relative term and means the change of position of any particular body with respect to other bodies. Newton's three laws of motion should be learned but they will not be repeated here.

Force is an impressed action upon a

body which tends to change its state of motion or its shape, for example, pressure, attraction, repulsion, etc.

Lift a 10-pound weight and the pull exerted is a force which tends to move the body. The muscular sensation in the arm conveys an idea of force and if a spring balance is put between the hand and the weight, the reading on the scale, ten pounds is the measure of the force.

It is well to train the mind to think of all substances as being made up of an indefinite number of infinitely small particles, forces of attraction and repulsion being always in operation between these particles, something as the earth attracts by the force of gravity all objects upon its surface.

Stress is a force action upon a body which tends to change its shape by distorting the particles of which it is composed or by changing their relative positions.

Strain is the distortion of a body due to the changing shape or position of its particles. There has been some confusion in the use of the terms stress and strain. One is a cause the other an effect. They have improperly been used as synonymous expressions.

Elasticity is the property, which most substances possess, of returning to their original shape after being strained.

1. A body weighs one ton at the earth's equator at sea level. How much will it weigh at the North pole or at an altitude of 5,000 feet?

2. How many cubic feet are there in a ton of soft coal?

3. How many quarts and gallons are there in a cubic foot of water?

4. Find the weight of a cast iron water pipe 16" in diameter and 12' long. The pipe is 1" thick and the bell end is 6" long; has an average thickness of 2" and a diameter of 18".

5. What is the specific gravity of a mixture composed of 20% of iron ore and the rest sand?

6. Write out and explain Newton's three laws of motion.

7. If the wind exerts a pressure of 20 lbs. per square foot on a building which is 50' long and 20' high, what is the force tending to move the building?

8. A force of two thousand pounds is applied to the ends of a steel rod ½" in diameter tending to pull it apart. What is the unit stress?

9. How much would a steel rod ten feet long and one inch in diameter stretch before it would break?

10. Which is the more elastic steel or concrete?

Symbols used in this chapter:

M=Mass.

G=weight in pounds.

g=acceleration of gravity=32.2.

Sheet Iron Ventilators.

The dimensions of sheet iron ventilators here given are some taken from a book of standards of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. Two styles are used, with and without a damper and the table shows the changes, also for the different pitches of roof. The size of posts and stiffening bars are the same.

Dimensions are in inches and the weights are in pounds.

The End in View.

BY PROF. A. EDWARD RHODES.

To obtain satisfactory results in any undertaking, we must aim to obtain a certain end. That is, we never make a drawing without having some definite object in view. It may be only a pleasant way of passing an idle hour, a desire to make a work of art, a desire for self-culture, or that drawing may be wanted for some one of the many commercial purposes. If the object is self-culture or if it is the teaching of mechanical drawing, it seems to me that a teacher friend of mine has nearly the right idea in the following outline of the course he teaches.

It will be seen that the day school opens he knows what he wants to teach at any lesson at any time during the school term, and also what is more important he knows what he wants to have accomplished at the end of the school year. For many schools the course would not be considered the ideal one, but this teacher's students are expected to have only a " smattering knowledge " of a great many fundamental principles rather than thorough knowledge of a few principles. Therefore, for this school it is just what he needs.

OUTLINE OF A COURSE IN MECHANICAL DRAWING.

Sheet No. 1.—Straight, horizontal, vertical and oblique lines.

Object.— To learn names of, and how to draw lines.

Sheet No. 2.— Straight and curved lines.

Object.— Learn names of, and how to draw lines, and necessity of accurate measurements.

Sheet No. 3.— Geometric Constructions.

Object.— Study of perpendiculars, and how to bisect a given line.

Sheet No. 4.— Geometric Constructions, as perpendiculars, polygons, etc.

Object.— Learning to measure with instruments.

Sheet No. 5.— Working drawing of point, line, and rectangular block.

Object.— Learn names and position of the several views and the study of shade lines in working drawings.

Sheet No. 6.— Working drawings of triangular prism with a square hole through it lengthwise.

Object.— Study of invisible edges.

Sheet No. 7.— Two views each of a square prism with a square hole; a square prism with a smaller square prism on top. A cylinder with a round hole, a cylinder with a smaller one on top.

Object.— Same as last.

Sheet No. 8.— Sheet of letters.

Object.— Study of simple letters suitable for working drawings.

Sheet No. 9.— Isometric drawing of small house and table.

Object.— To show a method of representing objects approximately as they appear to the eye.

Sheet No. 10.— Perspective drawing of columns of various heights and of a tiled floor.

Object.— Study of vanishing points and perspective measurements.

Sheet No. 11.— Perspective drawing of room with windows, tiled floor and door.

Object.— Same as No. 10.

Sheet. No. 12.— Perspective of board fence with student's name on it.

Object.— Same as No. 10.

Sheet No. 13.— Perspective of principle lines of row of houses.

Object.— Same as No. 10.

Sheet No. 14.— Perspective of house,

fence and a street.
Object.— Study of light and shadow placed on different parts of same drawing. Practice in composition.
Sheet No. 15.— Sectional and projected views of tilted rectangular block.
Object.— To learn why sections are used and how made.
Sheet No. 16.— Sections of hollow square prism and of cross shaped prism.
Object.— Same as No. 15.
Sheet No. 17.— Sectional and projected views of a tilted cylinder.
Object.— To learn to represent cylindrical objects when cut on a given plane.
Sheet No. 18.— Cylinder, hollow cylinder, elbow and cone.
Object.— Study of shop method of line shading.
Sheet No. 19.— Cone. Sphere.
Object.— Study of element of projection, to show how, when a given point is located, in one view, to find its position in another view.
Sheet No. 20.— Tilted square prism.
Sheet No. 21.— Tilted cube.
Sheet No. 22.— Tilted hollow hexagonal prism.
Sheet No. 23.— Tilted Latin cross.
Sheet No. 24.— Tilted initial letter of student's name.
Object.— 20, 21, 22, 23, 24 is to increase and show student's knowledge of principles involved.
Sheet 25— Truncated square pyramid.
Object.— To find length of any given edge.
Sheet No. 26.— Working views, and surfaces of a wedge, a triangular and hexagonal prism.
Object.— To learn how to develop surfaces of solids.
Sheet 27.— Truncated hexagonal prism.
Object.— Same as No. 26.
Sheet No. 28.— Elbow.
Object.— Study of development of curved surfaces.
Sheet No. 29.— Perspective drawing of small one-story house.
Sheet No. 30.— Perspective drawing of two-story factory.
Objects.— Of 29 and 30 is the study of advanced principles of perspectives.
Sheet No. 31.— Crank motion.
Sheet No. 32.— Crank and slotted cross-head.
Sheet No. 33.— Electric and strap.
Sheet No. 34.— Rachet wheel.
Sheet No. 35.— Cams.
Objects.— Nos. 31, 32, 33, 34 and 35, study of mechanisms and their functions.
Sheet No. 36.— Flange coupling.
Sheet No. 37.— Pedestal.
Objects.— 36, 37 study of machine details.
Sheet No. 38.— Cycloid.
Sheet No. 39.— Epi- and hypher-cycloid.
Sheet No. 40.— Diagram for proportion of teeth for wheel gearing.
Sheet No. 41.— Shop method for drawing teeth for wheel tearing.
Sheet No. 42.— Wheel and rack.
Objects.— 38, 39, 40, 41, 42. Study of wheel gearing.
Sheet No. 43.— V thread.
Object.— Study of principles involved in drawing.
Sheet No. 44.— Square thread.
Object.— Same as 43, and shading with India ink.
Sheet No. 45.— Make complete set of detail drawings of machine from assembled drawings.
Object.— Practice in making drawings.
Sheet No. 46.— From details of machine, make assembled drawing.
Object.— Practice in making working drawings.

Now, Mr. Home Student, have you got the idea? Do you positively know the end in view?

Elementary Course In Mechanical Drawing.

(Contiued from July Issue.)

In some drafting offices a drawing is made of an object with letters instead of figures in the dimension places and a table made with the dimensions of several sizes of machines to go with the diagram.

The illustration and table is of an engine crosshead and the student is requested to make a drawing and tracing with the dimensions in their proper places for the size 7x8 and make it full size, or he can make size 13x16 and make it half size. This is done where some of the sizes have been figured out ahead of the drawings and the latter to be made when needed.

This dimensioned tracing would then be checked, a blue print made and that sent to the shop.

"Checking" is the careful inspection of the drawing as to correctness of figures, proportions, etc., and should be done by someone well acquainted with the work.

Plate XXV.

This plate is to be the title page, to be fastened over the front of all the plates when the student has finished the course.

The sheet should be trimmed to 14x19 but a margin may be allowed of 2 in. on the left and 1 in. on the sides.

This concludes the Elementary Course in Mechanical Drawing.

(See comments on the course under head of Current Topics.)

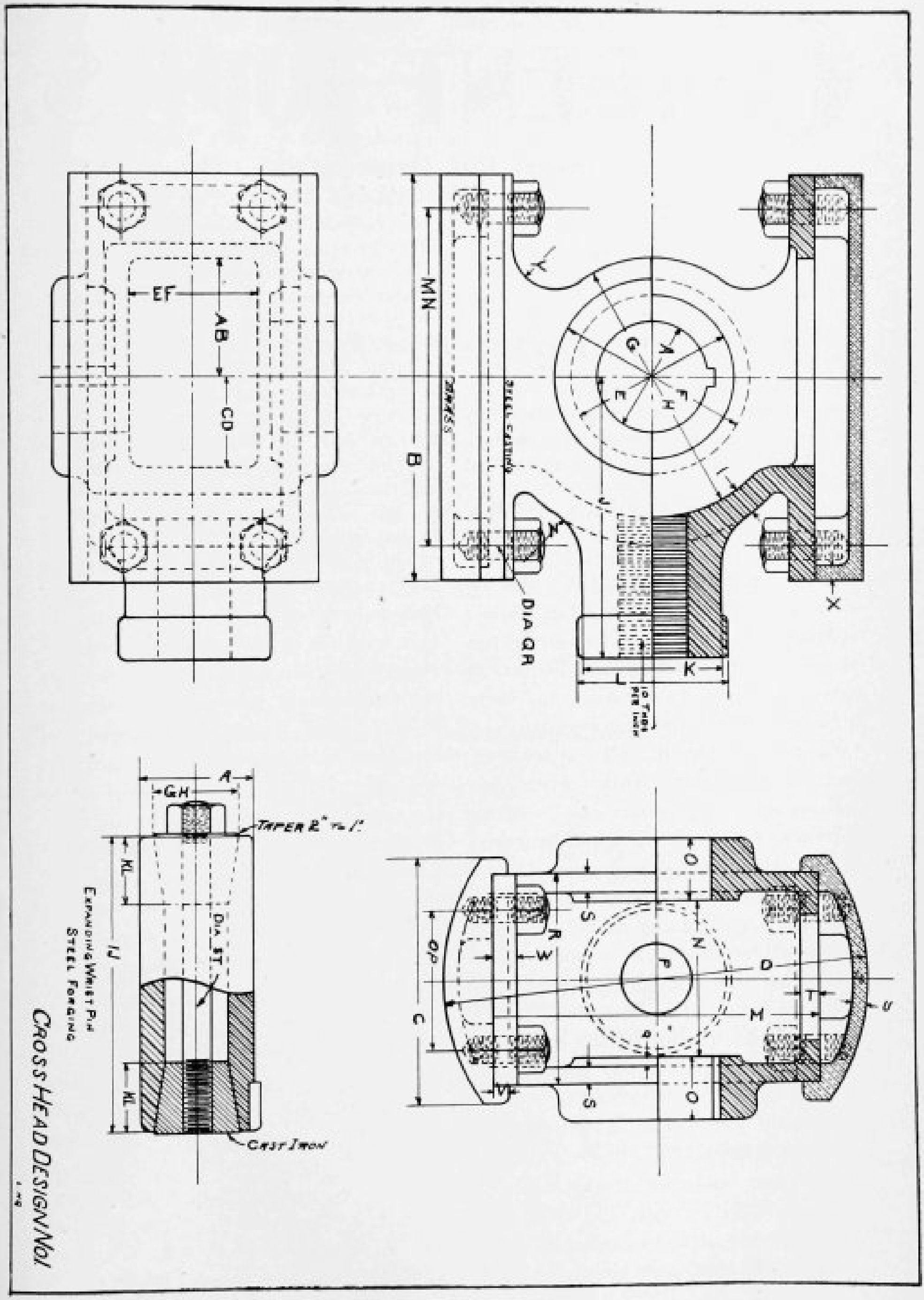
TABLE OF DIMENSIONS FOR BORED GUIDE CROSS HEAD, NO 1

FIGURED FOR A WORKING PRESSURE OF 125#

SIZES OF CYLINDERS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AB	CD	EF	GH	IJ	KL	MN	OP	QR	ST	SIZES OF CYLINDERS
7-8x8	2	7 1/2	4 5/8	7 1/2	2 3/8	3 1/2	2 3/8	2 1/2	5/8	5	2 1/2	2 3/4	5 3/8	2 3/4	1 1/8	1 1/8	5/16	3 3/4	5/16	5/16	1/4	1/4	7/16	1/4	3/4	3/8	2	1 5/8	2 1/8	1 1/2	5 1/4	1 1/8	6	2 1/2	1/2	1/2	7-8x8
9-10x10	2 1/2	9 1/4	5 1/2	9 1/4	3 7/16	4 3/8	2 5/8	3 3/8	3/4	6 5/8	3 1/8	3 1/2	7 1/8	3 3/8	1 3/8	1 5/8	1/4	4 1/8	3/8	3/8	5/16	5/16	1/2	5/16	1 3/16	1 1/8	2 1/2	2	2 5/8	1 3/8	6 3/8	1 3/4	7 1/2	3	5/16	5/16	9-10x10
11-12-13x12	3	11	6 1/2	11	4 5/16	5 1/8	3 1/2	3 5/8	3/8	7 3/8	3 3/4	4 1/8	8 3/8	4 1/8	1 5/8	2	1/4	5 1/2	7/16	7/16	3/8	3/8	5/8	3/8	1 1/8	1 3/8	3	2 1/8	3 1/4	2 1/4	7 1/8	2 1/8	9	3 7/8	5/8	5/8	11-12-13x12
13-14x14	3 1/2	2 3/4	7 1/2	12 3/4	5	6	3 5/8	4 1/4	1	8 1/2	4 3/8	4 1/8	9 3/4	4 7/8	1 7/8	2 3/8	1/4	6 3/8	1/2	1/4	7/16	7/16	3/4	7/16	1 7/16	1 5/8	3 1/2	2 3/4	3 3/4	2 5/8	9	2 3/8	10 3/4	4 1/8	3/4	3/4	13-14x14
15-16x16	4	14 1/2	8 1/2	14 1/2	5 3/4	6 7/8	4 1/4	4 7/8	1 1/8	9 5/8	6	5 1/2	11 5/8	5 1/2	2 1/4	2 5/8	5/16	7 1/4	7/16	5/8	1/2	1/2	3/4	1/2	1 1/2	1 3/8	4	3 1/4	4 1/4	3	10 3/8	2 3/4	12	4 3/8	3/4	7/8	15-16x16
17-18x18	4 1/2	16 1/4	9 1/2	16 1/4	6 7/16	7 5/8	4 3/4	5 5/8	1 1/4	10 3/8	5 5/8	6 1/4	12 3/8	6 1/4	2 1/2	3	5/16	8 3/8	5/8	11/16	9/16	5/16	1	9/16	1 11/16	2 1/8	4 1/2	3 5/8	4 7/8	3 3/8	11 3/4	3	13 1/2	5 3/8	7/8	1	17-18x18
19-20x20	5	18	10 1/2	18	7 5/8	8 1/2	5 1/4	6	1 3/8	12	6 1/4	6 7/8	13 3/4	7	2 3/4	3 3/8	5/16	9	11/16	3/4	5/8	5/8	1 1/8	5/8	1 5/8	2 3/8	5	4	6 5/8	3 3/4	13	3 3/8	15	6	1	1 1/8	19-20x20

"P" IS TAP SIZE.

Read the Want Columns Page 10.


EF
AB
CD
MN
B
BRASS
STEEL CASTING
DIA QR
L
K
10 THDS PER INCH
X
GH
A
TAPER 2" to 1'
KL
IJ
DIA ST
CAST IRON
EXPANDING WRIST PIN
STEEL FORGING
CROSS HEAD DESIGN No1
O
S
R
N
OP
W
P
D
T
M
U
C
V

CURRENT TOPICS.

Talent For Drawing.

By D. Eldred Wood.

Is it necessary to have a talent or natural ability in order to become an artist or draftsman? Can a person earn a good salary in the field of art without having natural talent?

These two questions have undoubtedly occurred to many persons who are interested in the subject of drawing. They are natural questions to ask, especially when one is considering the advisability of taking up the study of drawing. Many more people would become successful artists if they had not been frightened by the familiar saying of the wise ones (?) that "artists are born, not made." But let us consider the question. Let us see whether it is reasonable to ascribe the success of the well known artists of today so much to nature as to their persistent work and determination.

Do you believe that all the lawyers, doctors, ministers, bank presidents, bookkeepers, stenographers, electricians and hundreds of people engaged in the other occupations and professions are born with natural talent and have not acquired any of it? Do you really believe that? Is it not reasonable to say that not more than one out of every hundred is endowed with a few natural qualities which make his occupation or profession particularly easy for him?

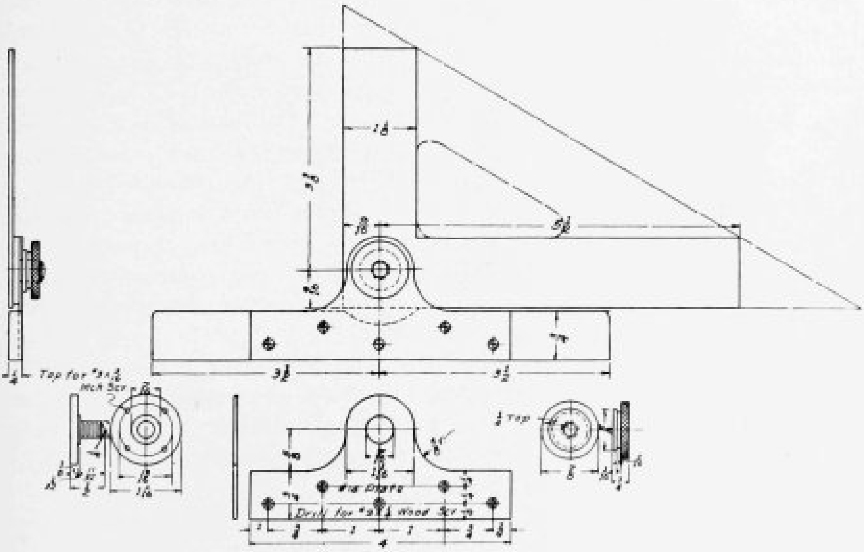
Now did you ever see a natural born penman—a person who never studied penmanship and yet could write a beautiful hand? Yes, did you say. Well, ask that person whether he could always write that same beautiful hand, or whether he did not acquire it by conscientious, persistent practice. In nine cases out of ten, he was taught to write just the same as you or I were taught, and after learning the first principles, there was aroused in him a latent faculty which he never knew he possessed, and he continued to practice until one day it came to be known that Mr. so-and-so had become an expert penman of perhaps national reputation. Then people said—after he has *made* his success—"of course he has natural ability."

Do you believe it is true that he had exceptional natural talent? Or rather is it not with the penman as it is with the doctor, lawyer, preacher, the bookkeeper, stenographer, in fact with everybody who achieves success in this world, he has been taught and has learned his profession; beginning with the A, B, C, and working up to the top? In law or medicine one must study and devote years to practice before they can be rated successful, and in the majority of cases, their success is the direct result of persistent study. This is not necessary in taking up the study of drawing.

You would not admit that you could not learn to write for you can write now. Neither would you admit that you could not learn law, medicine, bookkeeping, stenography, or any other subject if you *wanted* to, and liked it. Now, is it reasonable to say that you cannot learn to draw, when you are so deeply interested in it? Why can you not learn to draw and make a success of it as well as you learned to write? The very fact that you admire the beautiful, have a love for art and are so deeply interested in drawing would insure your success. It is not any harder and if you will devote your odd moments, just a little time each day, which is now wasted in many little ways, you can succeed and be able to accept a lucrative position before you know it. Artists and draftsmen are made, they are not always born with natural ability. They earn good salaries, and the work is pleasant. It is a source of positive delight for those who are interested in art of any kind, and drawing should be a material part of the foundation of the education and training of every well educated person.

Draftsmans Special Angle.

W. HOY BEADLEY.



Most draftsmen are fully aware of the trouble of making drawings on the skew, and while this may be done by shifting the straight edge, or using one triangle against another, yet it is tiresome to do so and where there is much such work to do, the sketch shows a very convenient tool which may be set at any angle to suit the design.

I made the blade out of an old 30° x 60° triangle, as the sketch will show, and it is fastened to the clamping screw by 4 3 x ¼ in. machine screws with heads countersunk in the blade.

The remainder of the sketch explains itself.

Sketch Pad For Isometric Drawing.

Isometric projection is that kind of representation by lines in which (in opposition to the geometric and polar

2—Draftsman—Fifner 22 22

projection), it is possible, with only one drawing, to represent any object as a solid body, even to one not skilled in the art; and to make on and obtain from such drawing on only one scale, accurate measurements in all three axes of main directions. These three small axes (lying in planes perpendicular to each other), of any isometrically represented object, lie on the flat surface of the drawing at angles of 120°; one of them vertical, the others 30° from the horizontal. No horizontal line of the original appears horizontal on the drawing.

An isometrically drawn cube has as its isometric outline a regular hexagon with three radii 120° apart; a circle lying on one of its faces appears in the drawing as an ellipse with major axis 1.225, minor axis 0.707 times that of the diameter of a circle.

To aid in forming these ellipses outlines are given that can be laid under the sheets.

These outlines aid in rapidly drawing perfectly isometrically projected ellipses in the three principal perpendicularly-lying planes of any object. In all of them the axial ratio is 1 : 3 = 1 : 1.732; that is considering the diameter of any circle as 1,000, the major and minor axes of the corresponding "isometrical" ellipse are 1,225 and 707. Either of ellipses is so laid on the drawing that one of them shall be tangent to the rhombus that represents isometrically the circumscribed about the circle to be projected. The outline is then pricked through with a point of any kind, and the curve afterwards filled in.

Ellipses with a larger major axis may be drawn by any number of ordinates, or approximated by circular curves. Smaller ones sketched in free hand.

Pads of sketch paper are made in 40 sheets each, in sizes, 6 x 9, 9 x 12 and 12 x 18, by The Derry Collard Co., 256 Broadway, New York.

Compendium Of Drawing.

The American School of Correspondence are issuing two volumes on the subjects of mechanical drawing, machine design, sheet metal drafting, shades and shadows, pen and ink rendering, perspective and architectural lettering.

The first two divisions are not altogether new nor made up in any original style but concise and to the point, illustrating the manner of arrangement of the instruction papers of this school.

The chief aim of this work is to acquaint the public with the standard, scope and practical value of these papers through an opportunity for personal examination. Although published primarily to show the character of the instruction offer and though they represent only a small portion of enough condensed practical information to make these volumes of value to the draftsman, student and teacher. For each there is form, style and proceedure, and this is what each one needs in his work.

There is at the end of each division a set of questions to be used for self improvement.

Pen and ink rendering is a department seldom brought out in a work on drawing and it is well arranged and illustrated.

Since so many superintendents lay stress on good lettering the draftsman is to be commended who will spend extra time on this work and the department of Architectural Lettering would be of great benefit to him.

The second volume is devoted entirely to Mechanical Drawing, Tinsmithing and Sheet Metal Drafting, concluding with a lot of useful tables and other lata.

The pages are as large as those of THE DRAFTSMAN, of better paper and all illustrations are clear and concise but not crowded, and the student would have before him a fund of useful matter from which to construct drawing plates.

The volumes of Compendium of Drawing are issued by the American School of Correspondence at Armour Institute of Technology, Chicago, Ill., to whom inquiries and orders should be addressed.

Allis-Chalmers-Bullock, Limited, announce that they have taken over the business and representation in Canada of the Bullock Electric Manufacturing Co., Canadian Bullock Electric Man'f'g Company, Ltd., Allis-Chalmers Company, Ingersoll-Sergeant Drill Company, Lidgerwood Manufacturing Co., Wagner Electric Manufacturing Co., Canadian Engineering Co., Limited.

The new organization will operate in the closest relations to the American companies and manufacture machinery identical in design and of the same high grade of material and workmanship, and can assure customers that with shops of the most modern design and equipment and the benefit of the wide engineering experience of the American companies, that the finest class of machinery will be produced.

EMPLOYMENT AGENCIES.

The National Engineering Agency, 1753 Champa St., Denver, Colo., are throwing out the old Greely saying, "Go West." They suggest to technical men and others to register with them since they think there are more openings than good men to fill them.

A good man never floats around loose very long before some concern hooks on to him and he hangs up his hat on their clothes rack, yet the higher positions are rarely filled through an agency.

The agencies in Ohio have been affected some by a law recently, imposing $100 license and a $500 bond upon them.

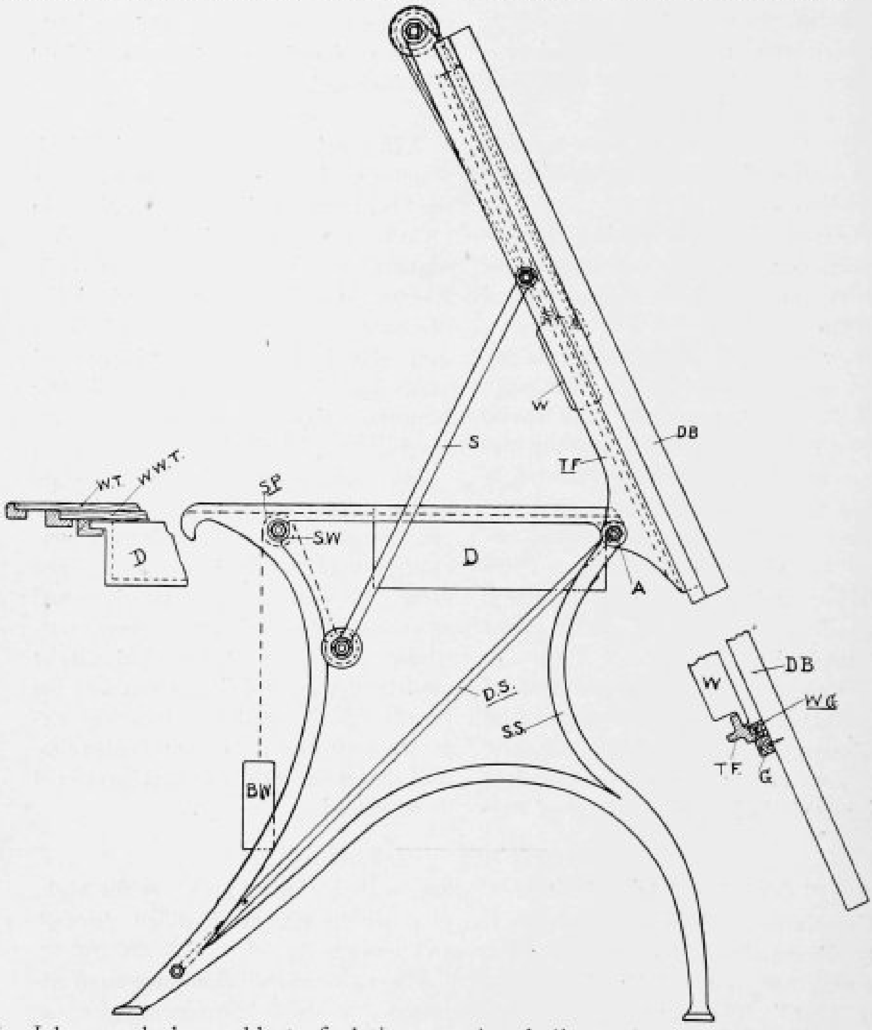
It is a good thing for those who can stand up to such requirements and the atmosphere some, especially in Cleveland.

Drawing Table.

R. W. DICKINSON.

I am very sorry that I have not had time to send you the sketch of Drawing Board before now and even as it is, I have only been able to find time to make a very rough sketch (very rough indeed) but trust it will serve its purpose.

Referring to the sketch, it will be seen that it consists of two side stands S. S. which are stayed sideways by a pair of diagonal stays DS. Pivoted to these are at A. are two T. F. These are also shown in Plain Section P. S., fixed to these are wood guides, W. G.



upon which the drawing board slides and is kept to its place by guides G. screwed to back of board. The board itself is balanced through a pair of cords over pulleys at top of T. F. by a weight W. Up to now you will see that the Drawing Board can be adjusted for height. Now for the tilting part.

The frames T. F. are held up by the stays (one at each side) S. are connected at the lower ends by a bar; fixed to the bar are 2 sprocket chains which go over 2 sprocket wheels, S. W. and to a balance weight B. W., so from this you will see that the angle of the board can be altered at will in a very short time. To hold the tilting frame T. F. in its position at S. P. is a spring pin which goes into a series of holes into the side of one of the sprocket wheels. Across the top of the side stands S. S. is a wood table W. T. (See end view.) Under this slide a table WW. T. which if the board is pushed up and this drawn out, forms an excellent table for writing or making calculations upon. Under this again slides a drawer D. in which books, instruments, etc. are kept.

Blue Prints From Typewriting.

W. H. WHEELER.

It often happens that instruction sheets, data sheets, bills and tabulated information of different kinds can be reproduced to better advantage by blue printing than by any other of the various methods of duplication.

This is especially true when the work on the original can be done on the typewriter instead of by hand, with a pen and India ink.

To get good results from the typewriter, a "black record" ribbon should be used. This is a non-copying ribbon and gives more opaque impressions than a copying ribbon,—the ink of the latter being almost perfectly transparent as far as the blue printing is concerned.

The matter may be on bond paper or on the dull side of tracing cloth. The former gives fully as good results and is usually more convenient to use, though requiring slightly more time for printing.

Specifications as well as data of all kinds may be quickly and accurately copied in this way. It would seem that lawyers and others could also use the process to good advantage for quickly obtaining accurate copies of abstracts, briefs and similar papers.

By the blue printing process, there is practically no limit to the number of copies that may be made and absolutely no question as to the accuracy.

(The samples shown, well illustrate the advantages expressed in the above and will no doubt be quite a help to many. Ed.)

DRAFTSMEN APPOINTED.

Harry V. Heimburger and C. S. Bainums have been appointed draftsmen in the building commissioners' office, St. Louis, Mo.

Instrument Case.

INSTRUMENT CASE.

The usual mathematical-instrument case, which consists of an under part for receiving the separate instruments (compass, tracing-pencils, and the like) and a cover adapted to fold thereon, is usually of such a width and length that if a large number of such instruments are to be placed therein it is not possible to carry such mathematical instruments in garment-pockets of the usual size.

Now by the present invention a suitable case for receiving a numerous set of mathematical instruments is obtained of a very convenient shape and form, the case being composed of three parts and the separate mathematical instruments arranged therein in two layers.

A mathematical-instrument case of this improved kind is shown in the accompanying drawings.

Figure 1 is an elevation, and Fig. 2 an end view of same.

Fig. I.

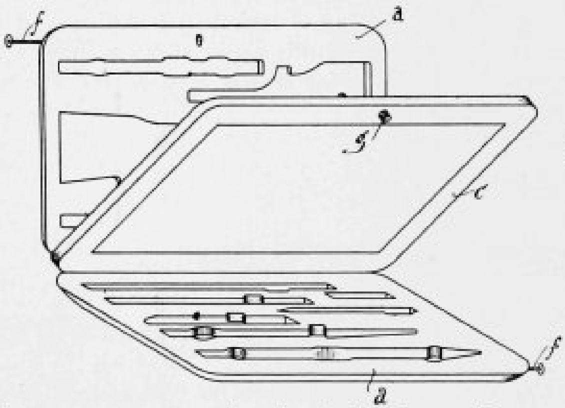
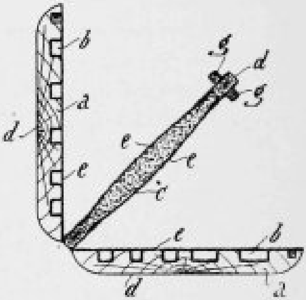


Fig. II.



In consequence of the arrangement hereinbefore described this improved case in spite of its handy shape and its comparatively small dimensions is adapted for receiving a very large number of separate mathematical instruments.

This is manufactured by Georg Schoenner, Nuremberg, Germany.

Engineer Draftsman.

Supervising Architects Office.

The U. S. Civil Service Commissioners holds an examination on Aug. 17, 18, 19 and 20, at the places mentioned on the enclosed list which is with the application blanks, to secure eligibles from which to make certification to fill a vacancy as Engineer Draftsman in Supervising Architects Office at $1,200 per annum and other vacancies as they may occur in that office.

The examination will consist of the

subjects mentioned below:

1. Mathematics (pure mathematics up to and including calculus, theoretical and applied mechanics with special application with the class of work to be done).

2. Materials and design (comprising knowledge in steel, iron, fire proofing, etc. and design of columns, girders, trusses, etc.).

3. Drawing, involving ability to draw designs neatly to scale, tracings, etc.

4. Educational training and experience.

Time alloted for examination, first day 5 hours, second day 7 hours, third day 7 hours.

Age limit 20 years and over.

Competitors should bring with them drawing board, not less than 15″ square, scale, drawing instruments, pencils, etc., and if you so desire slide rule.

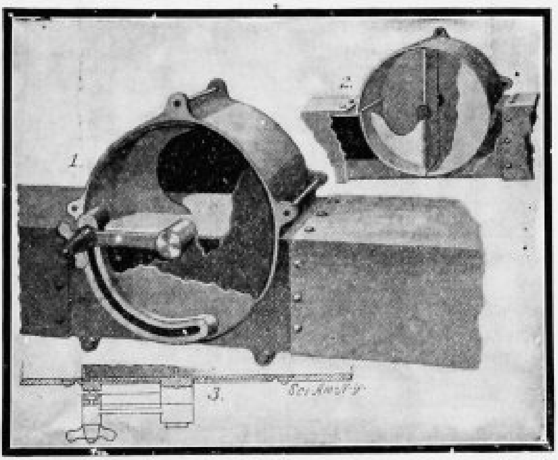
This examination is open to all citizens of the U. S. if they comply with the conditions.

Applicants will apply to the U. S. Civil Service at Washington, D. C.

A Grain Valve Cut Off.

In past years there has never been a satisfactory valve or cut off for grain or similar substances.

Mr. Geo. J. Noth, of Davenport, Iowa, has recently perfected a valve that has none of the faults of the others and many features to commend itself.



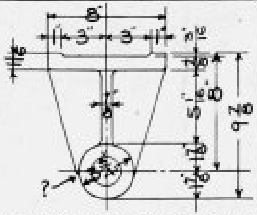
With it there is absolutely no leakage, whether it be ground corn or nut hard coal, when it is closed, *it is closed*. Then there is no crushing, mashing or shearing of grain, when opened or closed as with other styles.

It can be set at any desired opening without further attention and is easily attached and detached and less expensive in construction than other valves.

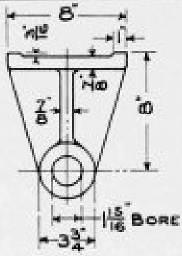
It is the result of many years investigation and study to obviate the faults and perfect the existing styles.

As seen in the illustration, the valve rotates clear of the passage offering no resistance to the flow of the material and the locking mechanism is clearly defined.

COMMON ERRORS IN MECHANICAL DRAWING.



SUPERFLUOUS DIMENSIONS POORLY DISPOSED, IMPORTANT ONE OMITTED, NO DISTINCTION IN WEIGHT OF LINES.



PROPERLY DIMENSIONED. CLEAR DISTINCTION.

SIDE VIEW OMITTED.

A BAD LINE.

A GOOD LINE.

WEAKENED BY ERASURE.

A BAD DOTTED LINE

AN AVERAGE ONE

WHICH LINE DOES THE ARROW MEAN?

EITHER WAY O.K.

LETTERING LIKE THIS TAKES UP TOO MUCH VERTICAL SPACE. —

Be Careful About Extra Tails On Letters

LETTERING LIKE THIS TOO SMALL AND CROWDED TO SHOW UP WELL. LINES NOT CONNECTED

THIS IS A HURRY UP JOB WITH THE RULING PEN.

Round Writing too Fancy.

Used more in structural than machine work.

PERHAPS THIS DESIGN IS BETTER LIKED.

DON'T SAVE INK. MAKE IT SO IT WILL PRINT WELL.

Dont Mix Styles of Printing. FORGOT HE STARTED VERTICAL.

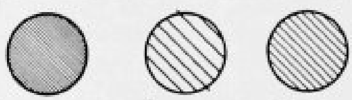
Shading Adds Nothing.

TWO WAYS OF SAYING THE SAME THING.

DRILL AND TAP FOR $\frac{3}{4}$" GAS PIPE. BETTER SAY, $\frac{3}{4}$" PIPE TAP.

$\frac{3}{4}$" CORED HOLES. BETTER SAY, $\frac{3}{4}$" CORE. 6" DIA. BORED. SAY, 6" BORE.

ONE RIGHT HAND, MARK B20.
" LEFT " , " B21.
RIGHT HAND ONE IS SHOWN.
BETTER SAY
1 AS SHOWN. B20.
1 OPP HAND. B21.



WASTE OF TIME. SLOPPY FAIR.

MAKE WORKING DRAWINGS FOR THE WORKMAN. IF PICTURE DRAWINGS ARE REQUIRED HIRE AN ARTIST.

MAKE TITLES COMPLETE BUT VERY CONCISE.
DON'T DRAW BOLTS UNLESS THEY ARE SPECIAL.
LIFE'S TOO SHORT TO SHOW NUTS IN PLAN.

C.I. = CAST IRON. W.I. = WROUGHT IRON. MAL. I. = MALLEABLE IRON. S.C. = STEEL CASTING. C.R.S. = COLD ROLLED STEEL. MED. ST. = MEDIUM STEEL. ST. = MILD STEEL. T.S. = TOOL STEEL. L.G.T.S. = LOW GRADE TOOL STEEL. M.S. = MACHINERY STEEL. BZ. = BRONZE.

J.S. MYERS, 1025 WALNUT, PHILA. 13MY04.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

SCROLL DRAWING.

Very often a little ornament in the way of a simple scroll will add to the appearance of a piece of work and therefore a few directions may be appreciated.

Fig. 1 shows a very simple scroll made of semicircles. To lay this off,

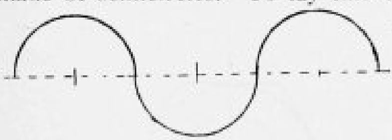


Fig. 1

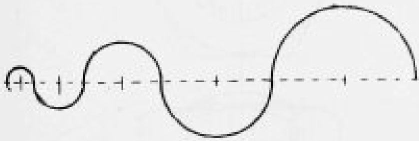


Fig. 2

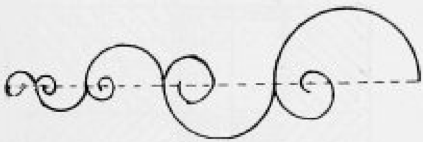
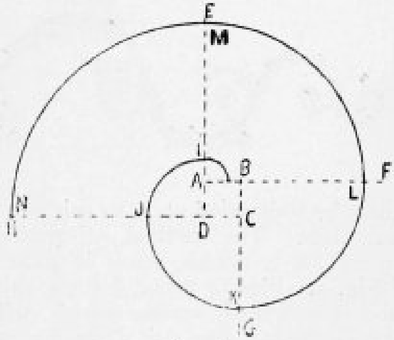


Fig. 3

draw a straight line and set off a number of equal distances; then with a radius equal to one of these distances, using as centers every other point, draw semicircles on alternate sides of the straight line.

Fig. 2 shows a tapering scroll. To lay this off, set off on the straight line a series of two equal spaces, each two spaces being smaller than the preceding one; then draw semicircles, as for Fig. 1.

Other portions of circles may be drawn from any part of the scroll, especially at the junctions of the semicircles, as shown in Fig. 3.



In Fig. 4, we give a method of drawing a figure resembling a spiral by arcs of circles. First draw a small square A B C D, and extend each of its sides, as shown, to the points E F G H. With the compass set to a small radium draw a quarter circle from the point A as a center, commencing at the line AF and ending with the line D E.

From the point D as a center, draw

the arc I J with a radius D I. In a like manner draw arcs, using successively the points C, B, A and D, the raduis for each arc being greater

Fig. 5.

Fig 6

than the previous one.

If desired the spiral may be commenced at the outside, drawing the successive arcs with a shorter radius than the previous one.

After the outline of scroll is drawn,

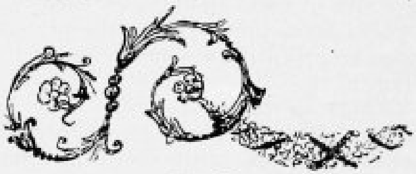


Fig. 7.

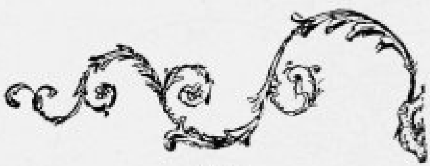


Fig 8.

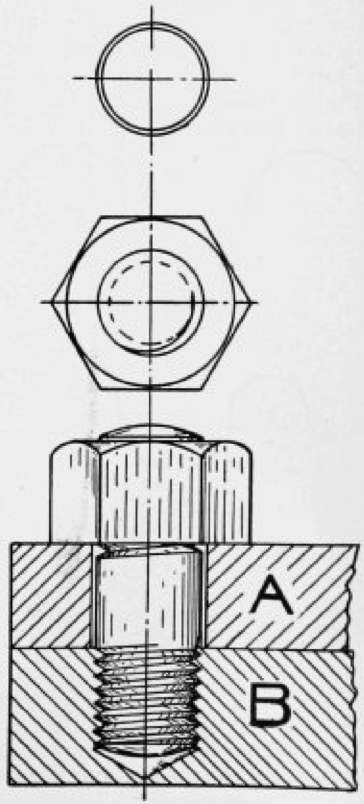
it may be elaborated upon to suit one's own taste. The method of getting centers for a double scroll is shown in Fig. 5. Figs 6. 7 and 8 show various ornamented scrolls which will serve as hints. Fig. 6 is after Fig. 5. Fig. 7 is an application of the spiral in Fig. 4, and Fig 8 is an elaboration of Figs. 2 and 3.

"Self Education."

Crude oil's economy in at least one direction over coal as a fuel is demonstrated in the run of a steamer from San Francisco to New York, in which three furnace men did the work requiring twelve stokers when coal was used.

Lettering is the title of a book by C. E. Sherman, a complete treatise on the subject stated. This edition of the book is bound in red cloth covered board covers, the body matter well printed and illustrated, there being several additions to the old text. The book is well suited for schools, in fact was originally designed for that purpose, but would be a fine addition to any draftsman's table. Postpaid $1.00. The Midland Publishing Co., Columbus, O.

England makes but a third of the the remainder $1,308,00 worth of it comes from America and $212,000 from Canada.

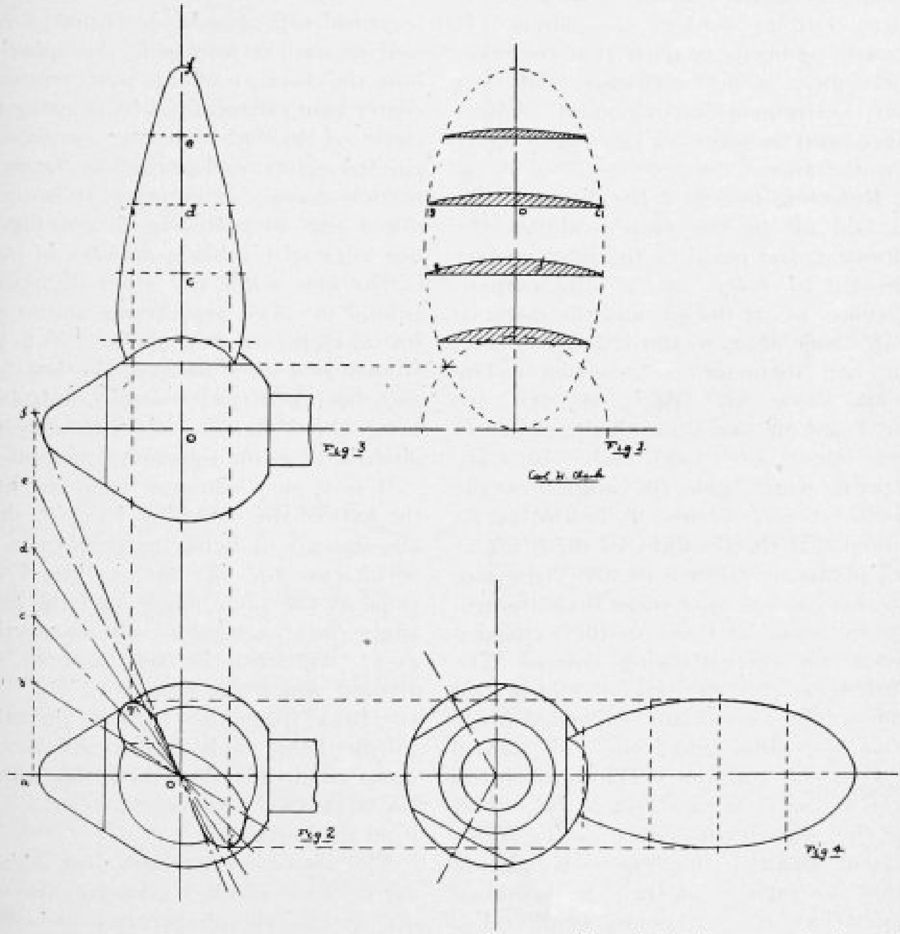


How to show a stud and nut and also a top view of the tapped hole.

MECHANICAL.

The Design of Screw Propellers.

By CARL H. CLARK.



In our last article on this subject we gave directions for determining the diameter, pitch, and blade area for any given circumstances, and it is the object of the present article to describe the process of making the working drawing of the propeller. Referring to the cut, Fig. 1 is the expanded outline of the blade, or the approximate shape which the blade would have if, instead of being twisted, it were a plane; it is eivdent that this is only approximately possible. Fig. 2 is the end view of the blade, looking directly down upon it;

the gradual twist is readily noted. Fig. 3 is the side, or athwartships view, and Fig. 4 is the rear, or fore and aft view.

Starting now with the expanded outline, this is usually of approximately elliptical shape and of the proper area to give the required blade area. For towboats and similar work where a large area is required the outline may be filled out at the tip; its usual width is from 4-10 to 5-10 of the radius. It should be borne in mind that the elliptical form is not necessary, but is a very convenient starting point. Allowance must be made for the hub in figuring the area.

Referring to Fig. 2 the distance o a, is laid off to the same scale as the drawing, and equal to the pitch in feet divided by 6.283; at "a" the perpendicular "af" is drawn, and the distance "af" made equal to the length of blade, or half diameter of propeller. The equal space "ef," "de," "cd," etc., are next laid off, and through the center O the lines "of," "oe," "od," etc., are drawn, which give the angles of the blade at each point. It is also to be noted that the breadths of the blade at all points are shown in their true size in this plan, so that these breadths will be the same as those in the expanded blade for corresponding points. The distances "ef," "de," etc., should be laid off on the axis of the expanded blade and horizontal lines, like "gi" drawn across the contour. The breadths in Fig. 1 "og," "oi" are now to be laid off in Fig. 2 from the center, as "og"-"oi." Each breadth from Fig. 1 is laid off thus in Fig. 2 on the corresponding pitch line, enough points being taken to define the blade outline, and new pitch lines being drawn if points are desired between those already drawn; the outline is then drawn in through these points.

To obtain the side elevation, Fig. 3, the distances "ef," "de," etc., are laid off as before; the intersections on Fig. 2 are then projected directly on to these lines. The fore-shortening effect of the changing angle of the pitch lines is shown in the pointed appearance of the blade. The fore and aft view Fig. 4 is obtained in a similar manner, by projecting horizontally, giving the outline as shown.

The hub in this case is spherical, with a conical cap. The blade outline is carried in until it intersects the spherical hub, the distance of this point from the center being determined by drawing the circle of the hub diameter on the expanded outline and projecting the intersection across, as shown. It is to be noted that in both Fig. 3 and Fig. 4, one edge of the blade appears in front of the hub, while the other disappears behind it. The projections shown are for a right hand propeller; if a left handed one were desired, the line "af" and the other spaces would be laid off below the center line, thus inclining the pitch lines in the opposite direction.

It is a very common thing to have the axis of the blade "of," Fig. 3, slope aft, instead of being perpendicular, in which case the line "af" in Fig. 2 will slope at the same angle, and the pitch angle lines, instead of all intersecting at O, will each be set back by the amount which the points "c," "d," "e" are back from the vertical; in other words these pitch angles will be the same as already described, but will be set back the distance that "c,d,e" are from the vertical.

The above description is for a blade, the pitch of which is constant throughout; in case the pitch varies, as is often the case, the points "c,d,e" will not all be on the same vertical, but each will be on its own vertical line drawn at a distance from O equal to pitch divided by 6.283, the pitch used being that at the several points "c,d,e."

The projectors described are those of

the working surface of the blade, the thickness to give strength being put on the back. The section at several points is shown by the sections on Fig. 1, these are nearly segments of circles, the thickness of the blade tapering from root to tip. It will be noticed in Fig. 2 that the center line of the surface is not at the center of the hub; this is because of the thickness of the blade, which is put on the back, thus bringing the center of the body of the blade about over the center of the hub.

The propeller illustrated has three blades, which are detachable; this accounts for the rather large hub, as it must be large enough to accommodate the flanges of the blades, which are set to the hub with a taper, and secured with bolts. The conical cap on the after end is put on to allow a free passage of the water and avoid eddies. When the propeller is cast solid, the hub can, of course, be made much smaller, it being only necessary to have sufficient metal to give strength around the shaft.

The various details of varying pitch, shape of blade, and design of hub, can only be dealt with generally in an article of limited length, as they are to a great extent governed by the experience and preferences of the individual draftsman or engineer. For a more detailed discussion of these matters the reader is referred to the various books and publications on this subject.

MINE VENTILATION.

Charles Kuderer, chief engineer of the mechanical department at the Monongahela Manufacturing company's plant, has made the following tests on his patent force or exhaust steel mine ventilator:

DIAMETER 6'—0" WIDTH 3'—0"

Revolutions per minute	300	400
Volume cubic ft. per minute	56,190	76,150
Pressure inches W. G.	6-10	1.
Ventilating pressure lbs. per sq. ft.	3.12	5.2
Work ft., lbs. in air	175,230	396,000
Horse power in air	5-31	12
Volume cu. ft. free air per minute	....	....

The ventilator tested has two inlets 3 feet 6 inches in diameter. The test showed 78 per cent. efficiency at 300 revolutions per minute. This is more than was expected and is entirely satisfactory to the company.

This ventilator is the invention of Charles Kuderer, and the Monongahela Manufacturing company have the exclusive rights to manufacture them.

The company expects to have large of their high efficiency in handling large sales of the new ventilators on account volumes of air. They are built of cast metal sections inclosed with steel plates, the whole forming a light and thoroughly substantial air-tight structure, and is also fire proof.

The ventilators will be made on the duplicate, interchangeable part system and in sizes from four to twenty-five feet in diameter. They are known as the Centrifugal, such as take air in the center or inlets passing through the wheel and discharging from the ends of the blades. Mr. Kuderer has the assurance of Thomas M. Evans, treasurer of the company, that if the sales warrant, the size of the plant here will be increased. These fans if properly cared for will last at least twenty years.

The inventor, Charles Kuderer, is a native of Elizabeth, New Jersey, and has been here for more than two years. He received his education at the International Correspondent School at Scranton, and has worked as draftsman in some of the best engine and machine works in New York and New Jersey.

Mr. Kuderer has other patents on ventilators pending at the present time, which when patented will be valuable additions to mine equipments.

The Four-cycle Engine.

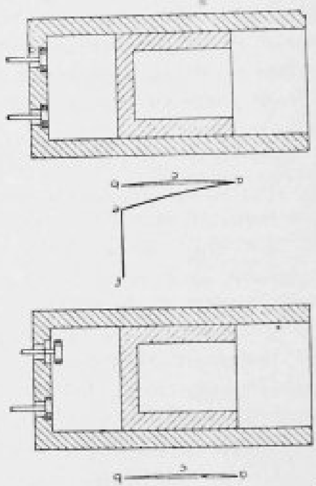
By Mr. R. T. Strohm.

The four-cycle type of internal combustion engine differs from the two-cycle in the fact that it requires four successive strokes to complete a single series of operations, while the latter requires but two strokes to complete the same round of events. In each case the same order of events is observed. First, taking in of the charge of inflammable gas; second, compression of this charge; third, explosion and subsequent expansion; and fourth, exhausting of the burnt gases.

Let us follow out the action of the four-cycle engine by means of sectional illustrations and indicator diagrams, both of which will make clear the sequence of the various events as nothing else might do. In Fig. 1 is shown a sectional view of the cylinder, with the piston at the head end of its stroke, ready to fill the cylinder with its explosive charge. With the starting of the piston toward the right, on its first forward stroke, the fuel inlet valve opens, and permits the combustible gas to enter the cylinder. If this gas flowed into the cylinder fast enough to follow up the advancing piston and fill the space made by its advance, the indicator pencil would trace a straight line as the indication of the suction stroke. But owing to the fact that the piston moves slowly at the beginning of its stroke, increasing in velocity until the middle of the stroke is reached, and then again decreasing in velocity toward the opposite end of the stroke, the pressure in the cylinder varies somewhat, and frequently there is a partial vacuum in the cylinder during the suction stroke. This is greatest at the moment when the piston is moving most rapidly, or near the middle of the stroke, and hence the suction line becomes a curved line "bca" lying slightly below the line of atmospheric pressure.

Having reached the outer dead centre position, the piston now returns, on its first backward stroke. Simultaneously with its reverse in direction of movement, the fuel valve closes. The combustible charge is thus encased in a closed chamber whose volume is being rapidly decreased by the return of the piston. The result of this compression is to increase the pressure of the gases, and this rise of pressure is manifested on the indicator diagram by the line "ae" in Fig. 2, rising gradually from the beginning of the return stroke. Thus, when the crank has completed its first revolution, the piston is in its first position, as shown in Fig. 1, but the compression chamber contains a volume of gas at high pressure.

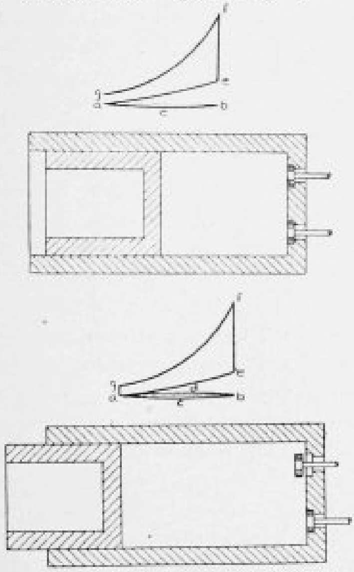
FIGS. 1 and 2.



At this position of the piston, the charge is ignited. The result of the combustion is the generation of a large amount of heat, which being absorbed by the burning gases, increases their pressure, and this rise of pressure is indicated by the vertical line "ef" on the diagram, Fig. 2.

The piston now starts on its second forward stroke, being impelled by the pressure of the gases. This movement increases the volume of the gases, and hence their pressure falls, as indicated by the line "fg," Fig. 3, until the end of the stroke is reached. This is called the expansion stroke or working stroke, since it is the stroke during which the engine is doing work received from the heat energy of the fuel. The corresponding diagram line is called the expansion line.

Upon reaching the end of its second forward stroke, the piston has moved as far to the right as it can go, and the greatest possible expansion of the gases has been utilized. Hence, at this juncture the exhaust valve opens, and the burned products are allowed to escape from the cylinder. The drop of pressure at the end of the stroke is represented on the diagram by the short vertical line "ga," Fig. 4.



FIGS. 3 and 4.

There remains now but one more operation to complete the cycle and return all parts to the same condition as at the beginning of the first forward stroke. This last operation is the second return stroke of the piston, by which the gases are expelled from the cylinder, as shown by the line "adb," Fig. 4. The conclusion of this second backward stroke brings the piston to the head end of the cylinder, as in Fig. 1. The exhaust valve closes, and the inlet valve opens, and the engine is in condition to repeat the cycle just mentioned.

In the actual engine, however, there are a number of modifying conditions which prevent the attainment of the form of indicator diagram such as that shown in Fig. 4. A representative card from a four-cycle engine is shown in Fig. 5. The line "ab" represents the line of atmospheric pressure. On the suction stroke, the pressure in the cylinder falls somewhat below that of the atmosphere, and consequently the suction line "bca" falls below the atmospheric line. On the return stroke, the compression line "ae" is formed. It will be noticed that the point "e" does not lie at the end of the diagram, but rather at a point just before the end of the stroke is reached. Explosion begins at this point, as evidenced by the rapid rise in the curve from "e." In other words, ignition takes place before the piston reaches the end of its stroke. This is one marked difference between the actual and the theoretical diagram. It will be seen that in the card on Fig. 4, the ignition takes place exactly at the end of the stroke giving a vertical explosion line. It is not practicable to have the ignition occur when the engine is on dead centre because it requires a certain short interval for combustion to be completed. Hence to realize the maximum explosion pressure at the beginning of the second forward stroke, ignition is made to occur slightly in advance of the dead centre position. The expansion line is "fg," release occurring at the point "g," instead of at the end of the stroke, as in Fig. 4, this being another particular in which the actual and the theoretical cards differ, since the fall of pressure cannot occur instantaneously upon opening the exhaust port. The expulsion of the waste gases takes place along the line "adb," which rises slightly above "ab" owing to the resistance to the passage of the gases through the port.

There is much rivalry between the builders of two-cycle engines and the builders of four-cycle engines, and since each type has given satisfaction in operation, each has its hosts of partisans. It may not be amiss, therefore, to compare the two with a view to observing their relative merits.

In the first place, the two-cycle engine has an impulse every revolution, while the four-cycle cannot have more than one power stroke in each two revolutions. As a result, the former would give a much more uniform turning effort than the latter, if each had the same weight of flywheel. But, the function of the flywheel is to equalize the turning effort. By it, energy is stored up when the effort of the engine is much greater than the resistance, and again given out during such portions of the stroke as the resistance is greater than the crank effort. Hence, by increasing the weight of the flywheel in the four-cycle type, it can be made to run as uniformly as the two-cycle engine. But the heavier flywheel makes the four-cycle engine much exceed in weight the two-cycle engine of equal power.

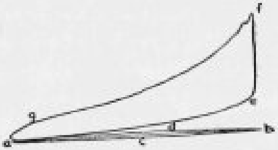


FIG. 5.

On account of the greater frequency of recurring of power strokes, the two-cycle engine is lighter, per unit of power developed, than the four-cycle engine. This makes it of value as the motive power for light vehicles, such as motor bicycles and tricycles, and especially valuable for airship propulsion. It is also a high-speed engine, being capable of making 2500 revolutions per minute, and being so, the force exerted upon the piston need not be as great as in a four-cycle engine of equal power. In other words, the parts of the two-cycle engine may be made much lighter than those of the four-cycle developing the same power.

But the four-cycle engine is by far the most widely used in automobile construction at the present time, and hence we may expect to find that it possesses advantages over the two-cycle engine which especially fit it for automobile work. Inasmuch as the explosions occur every other revolution, there is a short period in which the cylinder walls may cool down from the temperature to which the combustion has raised them. In the two-cycle engine the explosions follow each so closely that the cylinder becomes extremely hot, and this frequently leads to trouble. For if any portion of the cylinder walls or piston should become hot enough to fire the incoming charge, premature ignition would result, with consequent loss of power. With the two-cycle motor, the charge is compressed in the crank case before admission to the cylinder, and the governing is effected by throttling the exhaust. In case the engine is running under variable load, and the inlet port should open before the combustion is completed in the cylinder, the result is that the flame will run back and ignite the mixture in the crank chamber, and unless this mixture is promptly renewed the engine may slow up or stop altogether. The two-cycle engine has been particularly successful in driving launches simply because of the uniformity of the resistance.

The increased weight of flywheel of a four-cycle engine need not necessarily react upon it as a demerit. For, if desired, two, three, or four of these engines may be attached to the same shaft, and in that manner the turning effort may be made more uniform without the need of increased flywheel weight. The four-cycle engine gives better opportunity for satisfactory cylinder cooling, and by increasing its speed, the regulation may easily be brought down to limits which will compare favorably with the two-cycle engine. With regard to the friction losses in each, it would seem that there is little to choose in favor of either. The main points in selection of a motor are the nature of the resistance, the speed, and the regulation required.

—*The Motor Car.*

Chicago, August 8, 1904.

Editor Draftsman:

Your April number contains articles by both Mr. Florence W. and Mr. M. C. Hurd, who endeavor to show the error in Mr. Babbitt's construction "Something for our Geometrical Friends" in the December number. Both are wrong in saying that lines KE and CE are not equal.

Mr. Florence W. says, "The error is found in the assumption that KE equals CE." Now in the original article, no such assumption was made because lines KE and CE are positively made equal by construction. He then goes on to say, draw square ABDC, bisect BD and erect a perdendicular in G, making GE equal to the distance shown in the original. The original was a geometrical sketch and not a drawing, therefore it is incorrect to assume that line GE should be the same length as was shown. Point E is the intersection of the perpendicular bisectors of lines AC and KC and not where it was shown. It was a matter of convenience that it was so placed.

Hearing of no criticisms, I have reason to believe that my explanation on page 210 in the May number was about right. By giving a geometrical proof for this the problem would be changed entirely, in fact there would be no problem left. The catch was in making the original sketch out of proportion, with point E low enough to allow line KE to cross the square inside of point B.

I dare say this interesting little problem has aroused the thought of many a reader, thanks to Mr. Babbitt, and we would be glad to hear from him again.

Yours truly,

HOWARD MACDONALD.

530 Fletcher St., Chicago, Ill.

If greater accuracy in computation be desired, a correction should be made, taking account of the 6 per cent. loss in transformation. This, taken into consideration, would make the primary current for 1,000 watts output about .450 amperes.

Knowledge of the operation of artificial ice plants is becoming a valuable asset to the electrician who seeks to advance to the position of manager of Dixon's line. On the authority of one capitalist it is easier to get twenty engineers posted in electricity than one who can operate an ice plant. He says the value of cold storage plants and the necessity for their existence in the south are being slowly grasped and these offer a still larger field for a lighting plant south of Mason and growth and addition to both ice and electric plants. The economy of the dual operation of the two lines in one plant is emphasized in this part of the country, where the long summer evenings are spent out of doors and little burden placed on the lighting plant, the power of which may be readily used in the refrigerating plant. He cites one case in which, with the addition of an oiler and fireman to the regular force of a 300 kw. alternating plant, 100 tons of ice were added to the daily product.

Shafting, Turned And Rolled.

Some questions came up not long ago on the subject of shafting.

1st. Could a buyer get shafting with diameters in sixteenths, that is, 1 3-16, 1 5-16, or 2 7-16, etc., or would he have to order a 1-16 larger.

2nd. What were the standard lengths?

3rd. Advantages or disadvantages of turned, cold rolled and cold drawn.

Answers came from the following, which may be of interest to our readers.

(From Pittsburg Steel Shafting Co.)

Turned shafting is superior to shafting produced by either the cold rolled or cold drawn processes for the reason that by this process the surface of the metal is not laminated, and the bar is not subject to internal strains that cause crystalization and liability to fracture.

Cold rolling or cold drawing, especially where work is done too rapidly, will often so distort the structure of the steel that a bar will often break in pieces like glass when dropped on the floor. This will seem strange to those who have not actually seen such a thing. Such distortion of the metal is not possible in a turned shaft. In a cold rolled or cold drawn shaft there always exists an internal strain. This is proven by the fact that if a cold drawn or cold rolled shaft is keyseated on the surface, cut through for any purpose, the bar will spring out straight and will twist on its axis. This bar must be straightened again before it can be used. This twisting and bending after keyseating will not occur in a turned shaft, as there is no internal strain existing therein. By the old method of turning shafting in a lathe, with the bar revolving between centres, it was almost impossible to get the shaft perfectly round or parallel, owing to the wear and tear of tools, etc., and even by the use of a file it was not possible to make it perfectly true.

With our patent machines, however, it is possible to turn a perfectly round and parallel shaft to any diameter desired. After being turned our shafts are passed through smoothing and polishing rolls, which gives them a very high finish. After being cut to required lengths and carefully inspected for laps, seams, slivers and such defects in the surface of the steel, the shafts are put on testing rolls, on which they revolve; thus it is easily possible to determine whether or not the shafts are straight.

The shafts are carefully straightened until they revolve perfectly true on the rolls, when they are ready for shipment.

We therefore claim for shafting of our manufacture the following advantages:

1st. There are no existing internal strains, due to the process of manufacturing. This is especially desirable where strength is required, as it is frequently the means of preventing serious accidents, loss of time, money and life.

2nd. It has such a smooth and highly polished surface as to be attractive in appearance and especially adapted for use as piston rods.

3rd. Being carefully true to size, couplings, pulleys, etc., can be more satisfactorily and easily fitted to the shafts.

4th. Being perfectly round and straight it can be run at a very high speed without vibration or heating of journals.

(From the Jeffrey Manufacturing Co., Columbus, O.:)

"Replying to your favor of the 30th, ult., will state that our information concerning cold rolled shafting only applies to those sizes and uses which appertain to our business. We, of course, use large quantities of cold rolled shafting, ranging in size from 15-16 of an inch to 4 15-16 inch. If a firm were to order cold rolled shafting 2 1-2-in. in diameter, it would receive exactly that size, and not 2 7-16-in. Both sizes are made, but in common practice it has come to be the rule that the variations of sixteenths of an inch have been accepted as standard. However, it is still possible to get shafting 2 1-4 and 2 1-2 or 2 3-4 of an inch, but these diameters are not used extensively.

"We still find some people, more particularly in the South and in the New England States who order 2 1-2-in., 2 1-4-in. or 2 3-4-in. shafting. We presume that this is because they are repairing old machinery which was put in years ago when these sizes were more commonly used.

"In one line of work we still use the 2 1-2 and 3-in. shafts, viz.: in spiral conveyers. There is considerable of this size used for bearings in spiral conveyers on account of the fact that the conveyer is mounted on pipe of such interior dimensions that these sizes are best adapted to the use.

As to the lengths which are carried in stock by dealers, we find, generally, that dealers have lengths of 6, 8, 10, 12, 14, 16, 18 and 20 feet; they are not apt to carry anything above 20 feet, although we have found some dealers who do carry some pieces of 22 and 24 feet lengths; but ordinarily it is necessary to have the mills get out these longer lengths especially for the work."

(From Jones & Laughlins, Pittsburg:)

"We have your favor of the 30th, ultimo, asking for information in regard to cold rolled and other styles of shafting, and stating that the question has come up whether in ordering shafting 2 1-2-in., it would be 2 1-2-in. or 2 7-16-in.

"We would say in reply, that, in our practice, we always send the size of shafting that the customer asks for. In other words, if they specify 2 1-2-in. shafting they get 2 1-2-in., not 2 7-16-in.

"In regard to the lengths that we carry in stock, would say that we usually have on hand lengths running from 12 feet up to 24 feet. Standard lengths, as a rule, are 16 to 20 feet. All the shafting that we manufacture is cold rolled, the process of manufacture of which puts a polish on same."

Determining The Weight of Castings.

By C. M. Schwerin.

The instrument known as the Polar Planimeter was invented by Professor Andler in 1856, and is used to determine

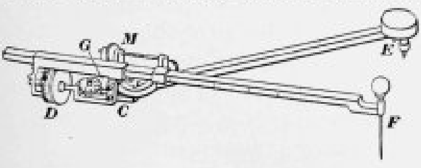


FIG. 1.

areas of irregular flat surfaces. As shown in Fig. 1, it consists essentially of three parts, the carriage revolving on measuring wheel D, the pole arm, to which is affixed the pole E, and the tracing arm, which carries the tracing point F. M is a screw adjustment for accurately setting the carriage which slides along the tracer arm. G is a recording dial, connected by the worm on the carriage with the measuring wheel D, which records the number of complete revolutions made by the wheel.

The area of any plane figure, no matter how irregular in outline, may be obtained by pressing the point of pole E into the paper and then tracing the outline of the figure with the tracer point

F. The complete outline must be gone around, and the tracer must return to the point from which it started. The wheel D will show the area.

The instrument can be set so as to read in square inches, square millimeters or fractions of any unit. All area instruments are made in various sizes, but the one with the 12-in. radius is the one most convenient for ordinary use.

The above instrument has been satisfactorily used for obtaining areas from maps drawn to scale and for obtaining area of indicator diagrams in making engine tests.

A particular use to which the foundrymen may put it, is to obtain the weight of a casting from the drawing of the pattern or of the casting itself, when the casting cannot be divided into regular geometric figures.

The following is an example of the calculation for two car wheel patterns.

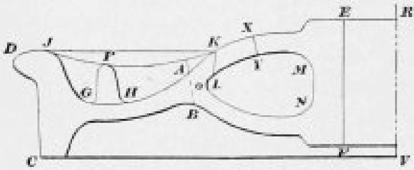


FIG. 2.

A car wheel pattern presents almost as complex a problem as it would be possible to have, so that the general idea here brought out could be modified to meet any class of work.

The object of this graphic method is to estimate the weight of the casting, which is to be made from a given pattern, when the cross-section is not a uniform geometrical figure. Such an estimate is a very important guide to the foundryman, who would otherwise guess at the probable weight of a casting of new design, and, in trying to be on the safe side, would probably melt an unnecessary amount of iron. It is also an aid to the designer of a new car-wheel pattern, who must otherwise from general experience determine the probable weight, have test wheels made, and correct the pattern afterwards, so as to obtain the weight prescribed.

For the method here described, an accurate drawing of the pattern is employed. This gives a closer result than a drawing of a wheel itself, for the following reasons:

1st. Calculations based upon the actual dimensions of the wheel involve the erroneous assumption that the specific gravity of the casting is uniform throughout; and upon that basis the calculated weight would be wrong because the amount of metal poured has shrunk in the mould, acquiring the highest density in the outside chilled portion, and growing less dense through the mottled to the gray portions.

2nd. Calculations based upon the dimensions of the pattern or "chiller" assume that the cooled metal will not have shrunk but will have the volume of the pattern and a uniform density.

These assumptions, though erroneous, counterbalance each other. For instance, the pattern and the chiller, which will give a wheel of 33-in. diameter when cold, are respectively 33.5-in. in diameter. This shows a shrinkage of wheel iron of about 3-16-in. per ft.

Ordinary gray iron is assumed to shrink 1-8-in. Wheels cast in 33.5-in. chillers do not always have the same diameter. They may vary 1-8-in. either way by reason of differences in composition, pouring temperature, duration of pouring, and also probably slight variations in cooling. But the average diameter is 33-in.; and it is found that a calculation based upon the 33.5 pattern, and the assumed uniform density of 0.26 lb. per cub. in. of molten wheel iron, as it fills the mould, gives correct weights of the wheels, even though the latter vary in size, as before explained.

For a casting of uniform specific gravity either the drawing of the casting, or that of the pattern, could be used. If the latter, then a percentage for shrinkage must be subtracted.

Fig. 2 shows, in reduced size, half the cross section of the pattern of an ordinary cast-iron car wheel.

From the full-sized drawing, divided by the line A B, as shown in the figure, the areas A, B, C, D, and E, F, B, A, are taken with the planimeter, and the areas L, M, N, similarly determined, are subtracted from their sum. The remainder is the area of the half-section of the pattern, exclusive of the brackets. Let this area (in sq. in.) be called A. The reason for dividing the drawing by the line A B, is because the planimeter was not large enough to measure the whole area.

The following calculation for two wheels is given as an example:

The calculation for $2 \times 3.1416 \times R \times A \times w$ was as follows:

	No. 1.	No. 2.
Area of E. F. C. D	52.38 sq. in.	53.17 sq. in.
Area, L. M. N.	12.42 sq. in.	9.60 sq. in.
Net area (A)	39.96 sq. in.	43.57 sq. in.
R	9.38 in.	9.25 in.
Cubic contents of pattern	2353.6 cu. in	2531 cub.in.
Weight (cub. cont. x 0.26)	611.95 lbs.	658 lbs.

The requisite addition for weight of brackets is approximately calculated as follows:

	No. 1.	No. 2.
Area G. P. H	2.24 sq. in.	2.30 sq. in.
Assumed average, ½ G. P. H.	1.12 sq. in.	1.15 sq. in.
Ave. length measured on curve.	10.5 in.	10.25 in.
Volume of one bracket	11.8 cub. in.	11.8 cub. in.
Weight (vol. x 0.26).	3.06 lbs.	3.06 lbs.
Weight of 13 brackets	39.78 lbs.	
Weight of 15 brackets		45.9 lbs.

NOTE: The 650-lb. wheels have 13, and the 700-lb. wheels 15 brackets.

The weights of the letters was obtained by weighing the same letters cast in lead, and taking seven-tenths of the result as correct for iron. This gave, for each wheel, 1.2 lbs

The amount to be subtracted for the metal displaced by the core-legs was calculated as follows:

	No. 1.	No. 2.
Thickness (x y) of bottom plate	[illegible] in.	1 [illegible] in.
Approx. av. diam. of core legs.	2⅝ in.	2⅝ in.
Area of base of equiv. cylinder	4.4 sq. in.	5.9 sq. in.
Volume of equiv. cylinder	4 cb. in.	6.5 cub. in.
Weight (x 0.26) for one core leg	1 lb.	1.7 lbs.

The final net weight for each wheel was determined as follows:

No. 1 . . . $611.95 + 39.78 + 1.2 - 3 = 649.93$ lbs.
No. 2 . . . $658 + 45.9 + 1.2 - 5.1 = 700.00$ lbs.

A blue print is then made, pasted on cardboard, cut out along the lines D, E, F, C, D, and L, M, N, L, and then balanced on a pinpoint, to determine the center of gravity of the irregular figure. This point (O in Fig. 2) is located on the tracing, and its distance from the center line of the wheel-axis, R, V, is measured.

Let this distance (in inches) be R.

If w=0.26 lbs. be taken as the weight of the metal per cub. in., and W as the weight of the wheel, then W=2x3.1416 xRxRxW+weight of brackets and letters, minus weight of metal displaced by the core-legs of the pan-core. The constant 3.1416 is the ratio of the diameter of a circle to its circumference.

The calculation for No. 1 was made from the pattern-drawing for a 650-lb. wheel; that from No. 2 from the pattern-drawing for a 700-lb. wheel. The cleaned wheels made from these patterns are averaging 655, and from 700 to 705 lbs. respectively.

Since a variation of 2 per cent above or below the regular weight can be easily caused by variable molding in the making of a car wheel, it will be seen that the foregoing method of calculation gives reliable results. For casting of soft iron and of more regular shape than the car wheels results could be more easily obtained.

The planimeter is an example of an essentially practical instrument based upon principles of the higher mathematics, and, while the operation of the instrument is remarkably simple, it requires the reasoning of the calculus to demonstrate the mathematical proof of its good work.

"The Foundry."

ELECTRICAL.

An Example of Transformer Design

By John Howatt.

In the last article, the general outline of the method employed in designing a transformer was given. In this article the design will be taken up in a more specific way, by means of an example of the actual calculations necessary.

In this example, let the following conditions be assumed: The transformer to be for a lighting load, 1,000 watts capacity, 60 cycles, secondary voltage 115 or 230, primary voltage 1,150 or 2,300. Let a regulation of 3 per cent. be assumed and an efficiency of 94 per cent. This latter would be a low value for any large transformer, but it is as high as could be expected in a 1,000 watt transformer. As a further assumption, let the transformer be of the shell type, oil insulating and self-cooling.

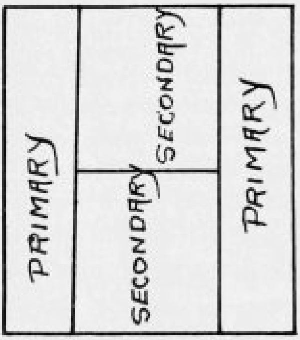


Fig 2,

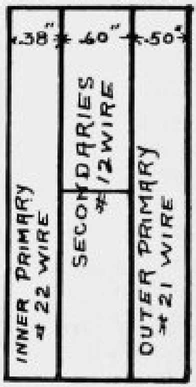


Fig 3

The first thing to be determined is the turns of wire in the primary and the secondary coils, and the total magnetic flux. Since the transformer is to be used on two different voltages, it is desirable to have at least two coils in the primary and two in the secondary, arranged to allow either to be connected in series or multiple for the different circuits on which the transformer is to be used.

Calling T the total number of primary turns, we have from the previous article

$$T = \frac{E \times 10^8}{4.44 \times N \times \Phi}$$

where E = primary voltage = 2300

N = frequency = 60

Φ = total magnetic flux.

Tables have been prepared, giving the different values of the flux O, as found in actual practice, the value depending on the size of the transformer and the frequency at which it is to be used. From these tables, the total flux for a 1,000-watt 60-cycle transformer is found to be about 300,000. Substituting this value for O in the above equation we have:

$$T = \frac{2300 \times 10^8}{4.44 \times 60 \times 300000} = 2880 \text{ turns.}$$

Since there are to be two primary coils, each coil will then have 1,440 turns. As the ratio of transformation is 10 to 1, each secondary coil will have 144 turns.

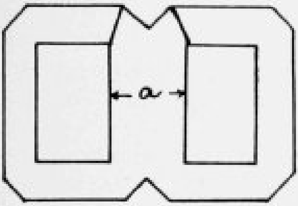


Fig 1

We now come to the question of what flux density to allow in the core. As a general statement, it can be said that the flux density decreases with increase of frequency. But even for transformers for the same frequency, the densities used in practice vary greatly. For 60-cycle transformers the values lie anywhere between 5,000 and 9,000 lines per sq. cm. In this case, assuming a value of 6,000 for B, we have as the cross sectional area of the magnetic circuit:

$$A = \frac{\Phi}{B} = \frac{300000}{6000} = 50 \text{ sq. cm.}$$

This is the actual cross section of the iron. Owing to the iron being laminated, however, the section of the core will be about 10 per cent. greater than the section of the iron composing it. This makes the core section 55 sq. cm., or 8.5 sq. in.

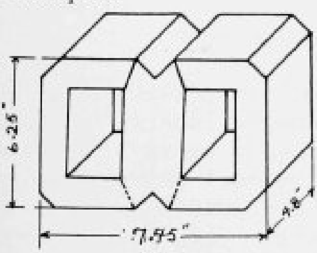


Fig. 4

It is now time to choose the shape of the stampings of which the core is to be built, and the shape of the core itself. The stamping shown below is one which gives very satisfactory results for small transformers.

Calling A the distance between the windows, then the following proportions for the stampings and core are used: Breadth of window, 1.2 to 1.5 a; Length of window, 2 to 3 a; width of punching outside of window, ½ a; length of core, 3 to 7 a. In this case, let the length of the core be 3.4 a. Now, as previously determined, the cross section of the core between the windows must be 8.5 sq. in. That is, $3.4a^2 = 8.5$ sq. in. or $a = 1.75''$, and the length of the core is 4.8 inches.

To find the size of the windows, we must now decide on how the coils are to be placed. For the purpose of better regulation, it is necessary that the primary and secondary coils be interspaced. The arrangement of coils shown below does very well.

In determining the space occupied by the coils, double cotton covered wire should be calculated for, and ⅛″ allowed all around for the purpose of insulating the coils from the core and from each other. With good insulation material, such as treated paper, this will be adequate insulation. No space need be allowed for oil circulation in either the core or inside the coil. With transformers of but 1,000 watts capacity the outside surface is large enough to keep down the temperature.

In determining the sizes of wire to be used in the primary and secondary, it is usual to allow a current density of from 1,000 to 2,000 circular mils per ampere, according to cooling facilities. It should be the aim always to distribute the heat as evenly as possible.

If we consider the transformer efficiency as 100 per cent., the primary current at full load will be 1,000 divided by 2,300 equals 0.435 amperes. In the secondary, for the same load, the current will be approximately 4.35 amperes.

Assuming a current density of 1,500 c. m. per ampere, this gives No. 12 B. & S. wire for the secondary and No. 21 and No. 22 B. & S. wire for the primary.

Since the outer primary coil is longer than the inner, two sizes of wire are chosen, No. 21 for the outer and No. 22 for the inner, in order to make the resistance of the two coils nearly equal. From a wire table we can now find the space that will be occupied by each coil. It will be found that the section of the first, or inner, primary coil, is 1.65 sq. in. The section of the outer primary is 2.2 sq. in. The section of each secondary coil is 1.25 sq. in. Then allowing ⅛″ all around for insulating and circulation purposes, and making the windows 3⅛A long we obtain, for the dimensions of the window, 4.5 in. x 1.98 in. and the dimensions of the coil section as shown in Fig. 3.

The average length of turn for each coil can now be obtained. This is best done on a drawing board, but can be computed to a fair degree of accuracy. For the inner primary coil, the mean length of turn is found to be 14.6 in. Its total length is then

$$\frac{1440 \times 14.6}{12} = 1750 \text{ feet.}$$

1,750 feet. Its resistance at 50°C is .018x1,750=31.5 ohms.

The mean length of the secondary turns is 21.10 in. The total length of wire in each coil is then

$$\frac{144 \times 21.20}{12} = 252 \text{ feet.}$$

252 feet. The resistance per coil at 50°C is .44 ohms.

The mean length of the outer primary is 25.8 in. The total length is

$$\frac{1440 \times 25.8}{12} = 3050 \text{ feet.}$$

=3,050 feet. Its resistance is 34.5 ohms at 50°C.

The probable losses of the transformer are now computed, to see if the transformer comes up to requirements as to regulation and efficiency.

The core losses will first be computed. In order to do this the volume of iron in the core must be known. Fig. 4 gives a sketch, showing the dimensions of the completed core. Its volume is 118 cu. in., or 1,940 cu. cm.

Knowing the volume of iron, V, the hysteresis loss in watts is given by the formula: $Wa = 10^{-7} \times N \times V \times N \times B^{1.6}$, where N is a constant depending on the quality $Wa = 10^{-7} \times 1940 \times 60 \times .0025 \times 6000^{1.6} =$ 32.3 watts.

The loss from eddy currents is found by the formula, $We = 1.645 \times V\ (dNB)^2 \times 10^{-11}$, where d is the thickness of the laminae in centimeters. Calling d=.03 cm. as a good working value, then $We = 1.645 \times 1940\ (.03 \times 60 \times 6000)^2 \times 10^{-11}$, or We =3.7 watts.

Then the total core loss=Wa+We= 36 watts.

Then the copper losses are next taken up.

The primary copper loss at full load= $I^2R = (.435)^2 \times 66 = 16.7$ watts.

The secondary copper loss at full load $= (4.35)^2 \times .88 = 13.4$ watts.

This gives a total copper loss at full load of about 30 watts; and the total transformer loss at full load will be 66 watts. Then the full load efficiency will be

$$\frac{1000}{1000+66} = 100 \times 93.8\%$$

Assuming a full load for 5 hours, and 19 hours each day no load, we have for the all day efficiency,

$$E = \frac{1000 \times 5}{(1000+66)5+(36 \times 19)} \times 100 = 83\%$$

Neglecting leakage, the drop at full load is found in this way: The primary IR drop at full load is 30 volts. Reduced to the secondary, this is 3 volts. The secondary full load drop is 3.9 volts. The total secondary drop of voltage then, from no load to full load, is 6.9 volts. The secondary voltage at no load being 230, the regulation obtained is 3 per cent. This is as good as can be expected on a 1,000-watt transformer.

HOME STUDY.

Mechanics.

CHAPTER II.

When a body is acted upon by two or more forces, it is often important to know the amount and direction of a single force which will produce the same effect upon the body as the given forces. This derived force is called a "resultant."

If two forces in the same plane are known in amount and direction, their resultant may be determined by completing what is known as the "parallelogram of forces," using the two given forces as sides. By this method forces are represented by lines, laid out to some convenient scale. Their magnitude is shown by the length of the line and their direction by the pointing of an arrow.

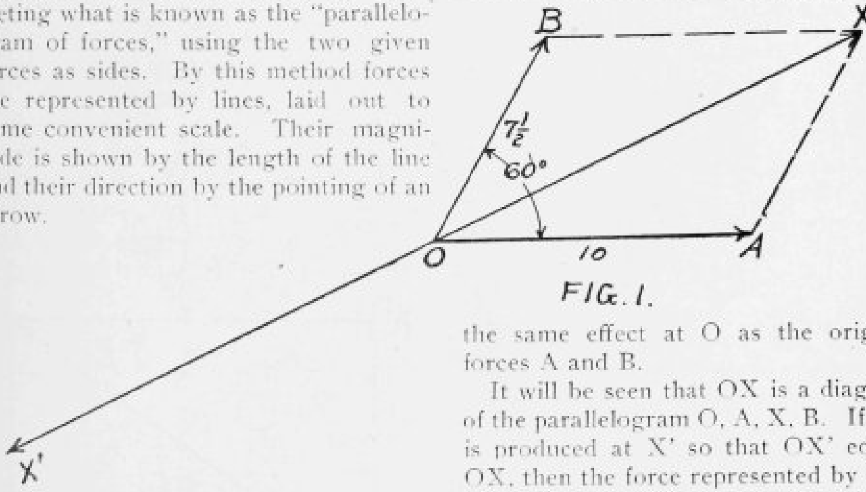


FIG. 1.

In figure 1 let A and B represent two forces of 10 pounds and 7 1-2 pounds, respectively, acting at the point O. Let the angle between them be 60 deg. and the scale of the drawing be 5 pounds to the inch.

To find a resultant force, OX, which will produce the same effect at O as the given forces.

With the T-square draw an indefinite line in the direction of OA, and with a protractor, or the 60 deg. triangle, draw another line in the direction of OB. Take a decimal scale and lay off OA, 2 inches long equals 10 pounds. Put an arrow at A. Then lay off OB, 1 1-2 inches long equals 7 1-2 pounds. From A, draw BX parallel to OA. Then from their point of intersection, X, draw OX, which will be found to measure about 3.05 inches, corresponding to 15 1-4 pounds. That is to say, 15 1-4 pounds, acting along the line OX, will produce the same effect at O as the original forces A and B.

It will be seen that OX is a diagonal of the parallelogram O, A, X, B. If OX is produced at X' so that OX' equals OX, then the force represented by OX' will balance OX or the two original forces. OX' is called the "anti-resultant" of OA and OB.

If the forces A and B are at right angles to each other, the resultant can easily be found without the aid of a diagram, for, by geometry OX equals OA^2 plus OB.

If the forces make any known angle other than a right angle with each other, we can still find the value of the resultant by the aid of Trigonometry. (For proof of this, see Church's Mechanics).

Suppose any number of forces in a plane are acting on a given point, then in order to find their resultant, the resultants of any two of them can be combined.

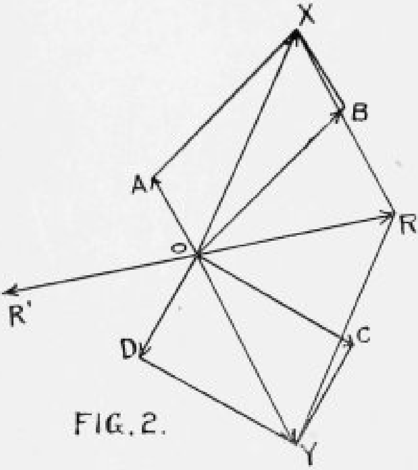


FIG. 2.

In Fig. 2, let ABCD be forces of 3, 4, 6 and 7 lbs. acting at O.

Lay off the forces to scale at the positions shown. Complete the parallelogram of forces on A and B and get the resultant OX, then using C and D get the resultant OY. Combine OX and OY and find OR as the resultant of the system. OR' equals OR is the anti-resultant which will balance the system.

If the given force in a system are not all in the same plane it can be shown that the resultant of the system is the diagonal of a parallelopiped, of which the given forces are the given edges.

If the forces in a system are all parallel, the resultant is the algebraic sum of the forces. In Fig. 3 the resultant equals (A plus D) minus (B plus C). The position of this resultant will be discussed later under the head of parallel forces and the center of gravity.

If we think of the resultant as the given force, it may be necessary to determine the amount of the forces along two or more directions, which when combined in the manner just shown will produce the given force.

These smaller forces are called "components" of the given force. If the direction of the components of a force are known, their value may be determined by proceeding backwards with the parallelogram of forces.

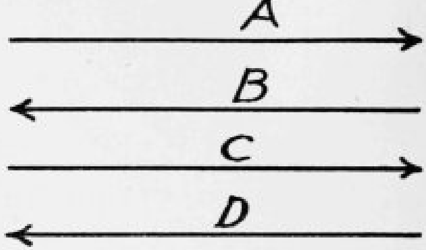


FIG. 3.

In Fig. 4 let OA represent the original force drawn to any scale known in amount and direction of its components, OX and OY, making the known angles A and B with it. Then through A draw a line parallel to OY and cutting OX, also through A draw a line parallel to OX and cutting OY. Then the portions cut off on OX and OY will represent the value of the components of OA. These values can be scaled off.

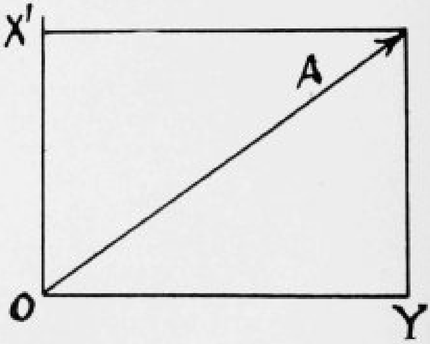


FIG. 4.

In such work as the solution of roof and bridge trusses it is often necessary to find the components of a force in order to determine what part of the whole load on the truss is carried to the supports by the various members.

QUESTIONS.

1. Two forces A and B of 10 and 5 lbs., respectively, make an angle of 60 deg. with each other. Find their resultant.

2. Find their resultant by geometry when the forces are at right angles.

3. The top of a derrick is supported by guy ropes, which, for convenience, we will suppose to be all in the same plane.

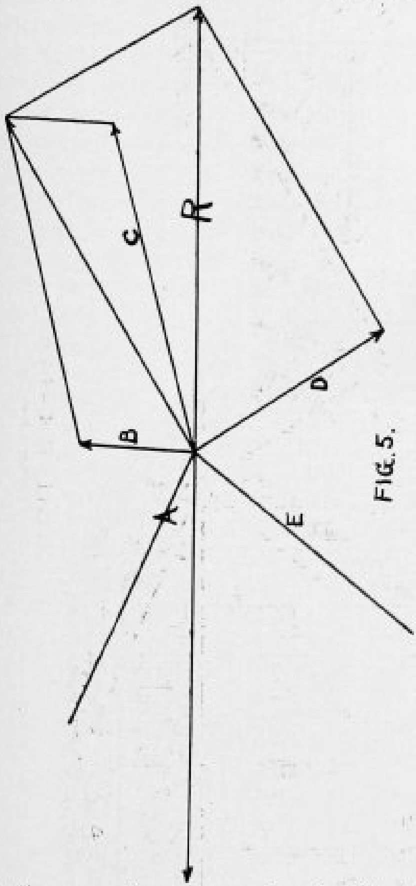


FIG. 5.

Let the ropes be arranged as in Fig. 5 and the derrick loaded so that the pull on the guy ropes is as follows. A and E=O, B=500 lbs., D=1,000 lbs., C=1,500 lbs. Adopt any convenient scale and find which way the derrick would fall, and the position and pull on a guy rope which would restrain it.

4. Fig. 6 is the end of a roof truss. Determine the horizontal and vertical components of the thrusts shown upon the wall.

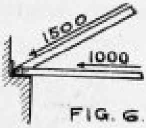


FIG. 6.

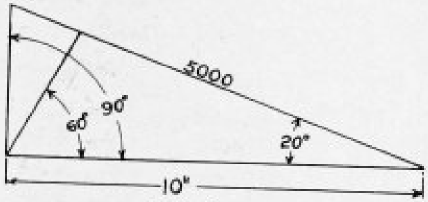


FIG. 7.

5. Fig. 7 represents a crank pin and rod. The angle of the rod with the horizontal is 20 degrees. Pressure along the rod is 5,000 lbs. Find the horizontal and vertical components of the pressure on the crank pin when the crank is vertical, also when it is at an angle of 60 degrees with the horizontal.

Elementary Course In Architectural,

The student is supposed to be able to use his instrument, to understand the simple geometrical problems and work, given in Part 1, of the Mechanical Course, especially projections.

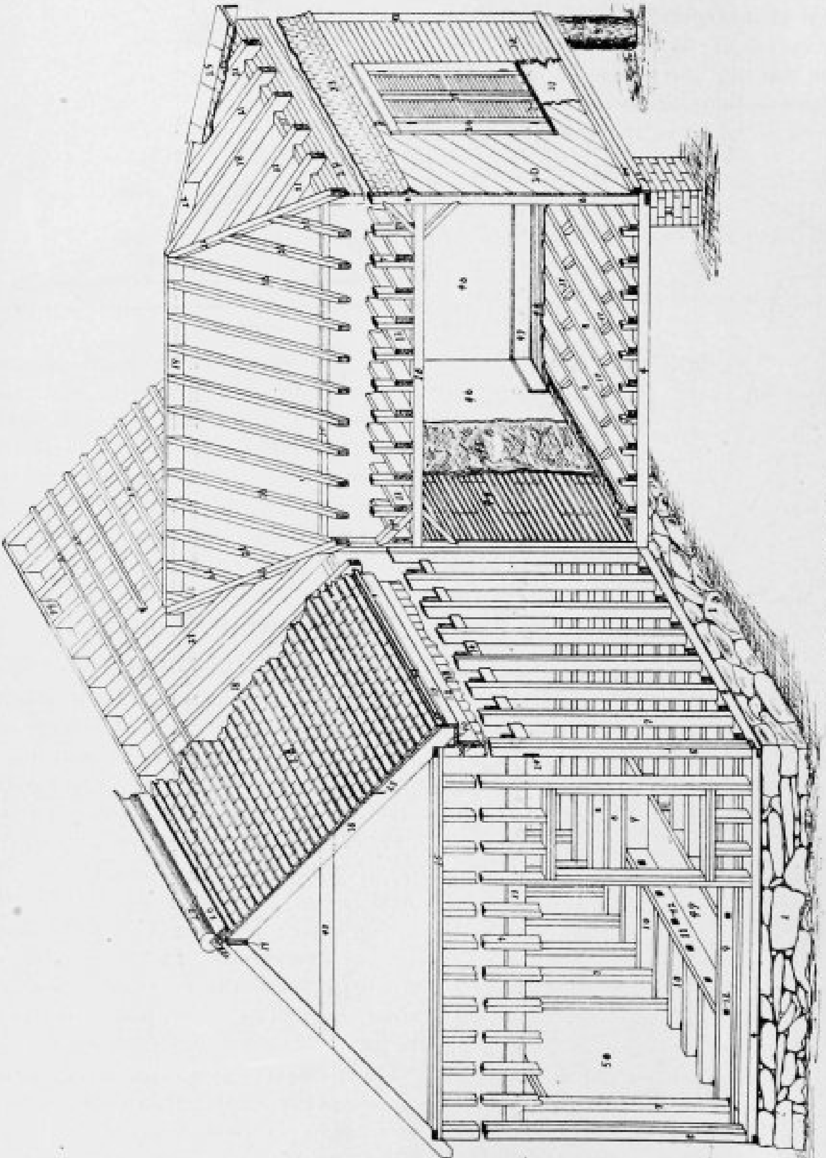
The arrangement of views on an architectural drawing should be the same as on a mechanical, that is, the top view or "plan" is above the front view or "elevation", and side elevation would take the place of side view and would be placed at the side nearest to the point of observing the view.

The architect's drawings are generally called "plans" and "elevations", a basement plan, a first floor plan, a roof plan, and two or three elevations are needed to convey a clear idea of a one-story house.

The word "story" meaning one room or one floor high, the height of a building depending on the number of floors.

The arrangement of the rooms in the first story is the drawing that an architect would begin on to determine the amount of ground space occupied by the house. If the arrangement, as suggested, would make a large and expensive house, then his skill must determine the changes.

There are standard names applied to all the pieces and objects used in the building, and for convenience we will begin with a frame house of simple design and of one story.



HOUSE CHART

Since the most readers were born and raised in a house of some kind, there are many things that need no description, such as doors, steps, windows, wood and brick, but mention will be made of some points of these objects which may have been overlooked by the student.

By referring to the "House Chart" the student will see a representation of a house in skeleton form, though partly finished.

The object of the chart is to locate, by number, from the following list, the various parts of a frame house.

A frame house is one made entirely of wood, except windows, chimneys, plaster, hardware, and sometimes slate for the roof instead of shingles.

The main body of the house to the left is the balloon-framed type, while the wing or part toward the right is of the braced frame type.

The names of the various parts are as follows:

1. Stone foundation.
2. Brick pier or pillar.
3. Post.
4. Sill.
5. Corner post of balloon frame.
6. Corner post of braced frame.
7. Studding.
8. First story beams or joists.
9. Trimmer.
10. Tail beam.
11. Header.
12. Mortise and tenon joint.
13. Second story beams or joists.
14. Ribbon or girt strip.
15. Plate.
16. Girt.
17. Bridging.
17′. Brace.
18. Common rafters.
19. Ridge.
20. Valley rafter.
21. Jack rafters.
22. Hip rafter.
23. Roof sheathing.
24. Purlins or shingle lath.
25. Flashing.
26. Ridge board.
27. Ridge roll.
28. Shingles.
29. Horizontal sheathing.
30. Diagonal sheathing.
31. Sheathing paper.
32. Clapboards or siding.
33. Shingle siding.
34. Water table.
35. Pitched cap of water table.
36. Window frame.
37. Shutters or blinds.
38. Frieze.
39. Facia.
40. Planceer or plancher.
41. Gutter.
42. Corner board.
43. Collar beam.
44. Lath.
45. Rough plastering.
46. Finished plastering.
47. Baseboard.
48. Flooring.
49. Well hole (for staircase).
50. Door opening.

INTERIOR CHART.

"The object in presenting this chart is to give the various names of interior woodwork, etc. To get this within a reasonable compass and to show different styles of trim, etc., it is necessary to group the various designs together. Some of the details are exaggerated in size compared with the scale of the drawing, so as to show them plainly."

1. Sill.
2. Sub-sill.
3. Furring.
4. Quarter rounds.
5. Sill cap.
6. Header.
7. Pocket, or opening to weight box.
8. Blind-hanging stile or exterior casing.
9. Exterior sash stop.
10. Clap-boarding, shingles, or outside covering.
11. Sheathing or roof boarding.
11′. Sheathing paper.
12. Stud.

13. Laths.
14. Plastering.
15. Architrave, interior casing or window trim.
16. Stop bead.
17. Parting bead or strip.
18. Pulley stile.
19. Sash weights.
20. Window latch or sash lock.
21. Pulley.
22. Sash cord.
23. Meeting rail of outside sash.
24. Meeting rail of inside sash.
24′. Bottom rail of sash.
24″. Top rail of sash.
25. Stop head.
26. Window head.
27. Exterior casing.
28. Sash stile.
29. Astragal or sash bar.
30. Sash lift.
31. Window pane or glass.
32. Panel back or breast.
33. Base blocks.
34. Window trim, casing or architrave.
35. Corner block.
36. Window trim.

(The lists and illustrations are reproduced from an article by Mr. Albert Fair, in "Self Education for Mechanics", published by The Industrial Publication Co., New York).

Mechanical Drawing Course II

Introduction.

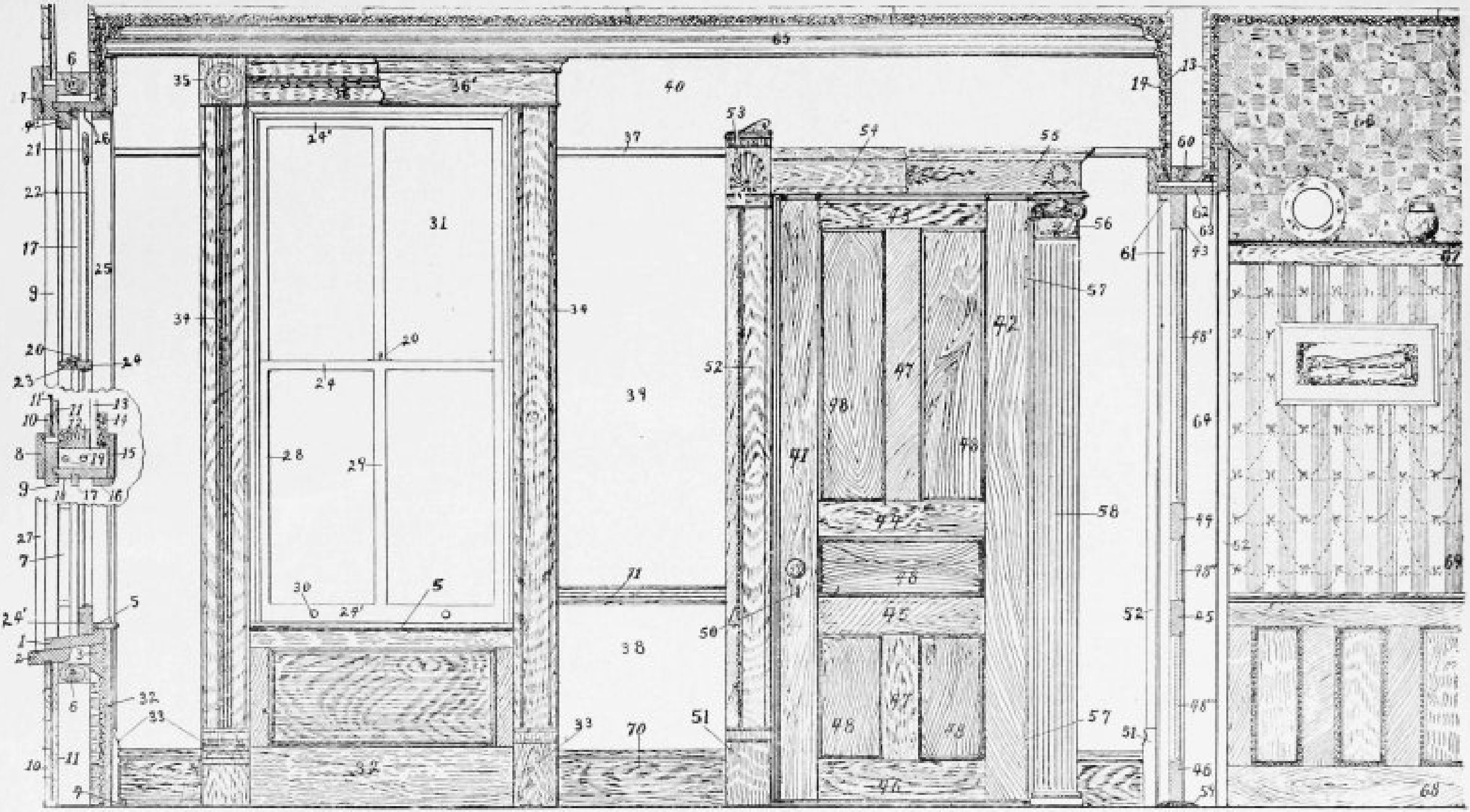
Before beginning the work of this course, the student is supposed to have completed Course I, of this series, on Elementary Mechanical Drawing. It is necessary for him to be familiar with the more common geometrical constructions, to understand what is meant by orthographic projection, and to be able to apply his knowledge. He should know how to make sections and developments of objects, and have enough knowledge of working drawings to enable him to take up the more advanced and difficult problems of this course without much hesitation. Any student who has completed Course I and the Intermediate Course, or their equivalent, should have no trouble in taking up the work outlined below.

This course will include sketching and drawing from the model, the working out of secondary views having given the principal view, a study of shafting, bearings, keyed, riveted and bolted connections, pipe fittings, pulleys, cams and gearing.

Each principal is illustrated by an example taken from actual practice. The course is adopted primarily for use in evening school work, where measurements can be taken from the model and where the pupil is under the direction of the teacher; but for the benefit of the Home Study Department, photographs of the models used will be published, and printed instructions will be published with the plates.

At this point the student is advised that it is time for him to begin to break away from the illustrations and descriptions of the text books, and to think things out for himself. These problems are planned to lead the student up to the practice of machine design, and while teaching him to think, they have been so chosen as to supply him with a fund of useful knowledge. It is hoped that the process of mental training can be made interesting by choosing the work that the student is required to do, from actual probems found in every day engineering practice.

Too much emphasis cannot be laid on reading. Read the technical books and magazines, in connection with the work, and find out how others are doing things. A list of questions is given with each plate. These questions are put with the idea of directing the attention to the most important points, and



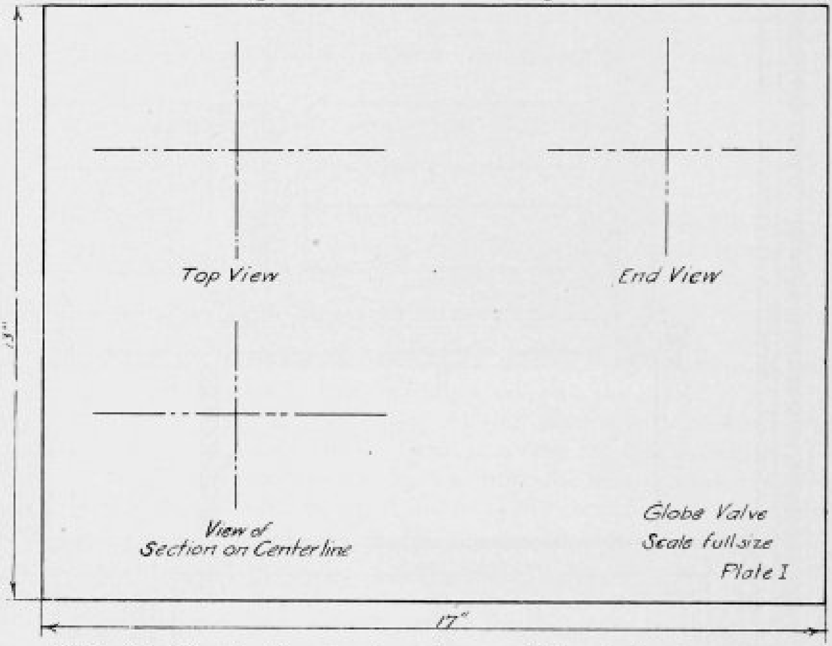
Interior Chart.

the student is advised to read up or inquire from experienced mechanics, and write out complete answers to all the questions. Following is a list of reference books and magazines:

"American Machinist", "Power", "Engineering News", "Engineering Record", "Engineering Magazine", "Cassiers Magazine", Unwin's "Machine Design", "Ripper's Steam", Stahl & Wood "Elementary Mechanism", Barr's "Kimematics", Benjamin's "Notes on Machine Design", Rose's "Steam Boilers", Kent's "Engineer's Pocket Book", Carnegie's "Pocket Book", Ried's "Elementary Drawing & Machine Design", Rose's "Pattern-Maker's Assistant", and "The Draftsman".

Sketch and Detail of A Globe Valve.
(From Model or Photograph).

Few designers are practical pattern-makers or machinists, but every draftsman who expects to get out work for the shop must know enough of each of these trades to enable him to furnish just the information that the mechanic wants. He should know what shapes can be easily manufactured and what cannot; he must be able to consider the "cost" of doing things, for it often happens in engineering that the "best" way is simply the cheapest way. Some knowledge of pattern-making is of the greatest importance to the young draftsman. Without being expected to know all the ins and outs of the trade, he will find that some practical knowledge of it is indispensable to his success as a designer. He should study the theory of it in the books and magazines, and watch practical men at every opportunity.



On this plate we shall make a short study of patterns, as illustrated by a three-inch globe valve.

DIRECTIONS.

Make free hand sketches, showing three views of the model valve. One view is to be a section lengthwise through the center of the valve, one view is to be a plan looking down on top, as it stands in its upright position, and the third view is taken looking at the end. The model should be measured up with a "shrink rule", and all the dimensions put on the free hand sketches in good order. The three sketches may be made on separate pieces of paper. It is better to keep a note book for this purpose and preserve all sketches. After the free hand sketches have been checked by the instructor, the views may be laid out to scale in the order shown by the illustration, Plate I. The sectional view should be started first, and then the other views found by projection from it. Work all three views together, by so doing mistakes will be avoided.

The student is left to choose his own scale.

QUESTIONS.

1. What are some of the qualities of good pattern lumber?

2. What machines would you find in a well-equipped pattern shop, and what is the use of each?

3. How does the pattern-maker use the drawing furnished him by the draftsman?

4. What is a shrink rule, and why is it used?

5. What is a core box, and how is it used?

6. Define: Core print, draft, rapping, green sand, dry sand, cope, drag, flask, mold.

7. Name in their order, and describe in about two hundred words, the processes that the pattern-maker goes through in building up his pattern.

8. Estimate the weight of the casting from the model globe valve.

(See a table of specific gravity).

9. How much will the rough castings cost apiece?

10. Find out the market value of a valve of this size, and make an approximate statement, showing cost of rough casting, finishing, dealers' profits, etc.

Course I was completed in August issue of THE DRAFTSMAN, and anyone who would like to take up the lessons may secure them in booklet form by writing to this magazine.

In The World of Science.

In a paper read by Arthur Gulston, a British engineer, before the Society of Arts, some remarkable facts were stated regarding the work of vessels built for breaking ice in navigable channels. Mr. Gulston rates the Ermack, a Russian steamer intended chiefly for use in the Baltic Sea, the most powerful of these modern aids to winter navigation in cold countries. The Ermack is 335 feet long, and has remarkable breadth of beam, the extreme being 71 feet. The displacement of the ship is 8,000 tons, and her draught of water is 22 feet. In solid ice two feet thick, covered with from six to twelve inches of snow, the Ermack can make ten miles an hour, while in the Arctic Ocean the vessel has broken up and forced a passage through packs of ice twenty to thirty-five feet thick.

In a curious article on the "Life and Diseases of Metals," published in Harper's Magazine for April, Professor Heyn, of the Technical Experiment Station of the Royal Polytechnic School, at Berlin-Charlottenburg, asserts that metals can be poisoned, much as animals often are, and that metals so diseased may be brought back to normal condition again, in many cases, by proper treatment with remedies which may fairly be likened to the medicines used as antidotes for poisons in protecting human life. Professor Heyn brings forward much evidence, microscopic and physical, to show that the growth of vegetables can be so closely paralleled in minerals when favorable conditions are created, that the effect upon the observer of the process of accretion is to suggest that the line of division between organic and inorganic substances is by no means so clear and certain as it is commonly supposed to be.

CURRENT TOPICS.

The Other Fellows

—The other fellow's job

There's a craze among us mortals that is cruel hard to name,
Wheresoe'er you find a human you will find the case the same;
You may seek among the worst of men or seek among the best,
And you'll find that every person is precisely like the rest.
Each believes that his real calling is along some other line
Than the one at which he's working—take, for instance, yours and mine.
From the meanest "me-too" creature to the leader of the mob,
There's a universal craving for "the other fellow's job."
There are millions of positions in the busy world today,
Each a drudge to him who holds it, but to him who doesn't, play;
Every farmer's broken-hearted that in youth he missed his call,
While that same unhappy farmer is the envy of us all.
Any task you care to mention seems a vastly better lot
Than the one especial something which you happen to have got.
There's but one sure way to smother envy's heartache and her sob:
Keep too busy at your own, to want "the other fellow's job."

—Strickland W. Gillilan, in Success.

Electric welding of metals is fast becoming more important and more common in the manufacture of carriages, agricultural machinery, automobiles, bicycles, and other like industries. Among the advantages claimed for the electric process are rapidity, flexibility, cleanliness, neatness, accuracy, and economy.

In the rush to get in a large press and the delay of the August issue, the supplement was omitted, but two copies will be found in this issue.

There will be none in October issue, but two in November and two in January, and perhaps one each month thereafter.

One subscription has been received for five years for three dollars. We would like to have as many as possible.

Our "want" columns were greatly revised in the August issue, and there is much new matter there now.

Always mention THE DRAFTSMAN, when writing to advertisers.

There are many ways of earning a subscription or premium with this magazine. Write for lists and catalogues of books.

Some of the newest types of heavy locomotives place the weight of the whole engine on a few drive-wheels, so close together that the strain on bridges from the use of such tremendously heavy machines must be serious. An electric locomotive, built for the New York Central Railroad Company, has its front and rear driving wheels only thirteen feet apart, and there are eight wheels, each carrying 17,000 pounds. That puts sixty-eight tons on thirteen feet of track.

How to Straighten Paper.

As shown in the illustration, hold the paper or tracing cloth by the corners or by the ends, and draw down over the sharp corner of the drawing board or table.

Sometimes a better result may be obtained by laying the hand on the sheet at the table edge and draw the sheet through with the other.

Paper that has been rolled will be easily straightened by this method.

"De man dat has to learn by experience," said Uncle Eben, "is gener'ly so near broke when he gits his infohmation dat he can't use it."

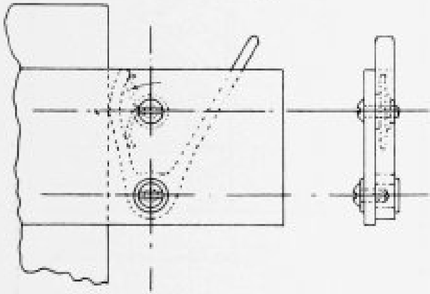
Brain Fag.

Brain fag is the bugaboo of the weak-willed and the lazy. It never frightens the youth of real talent. It has no terrors for the boy who is sitting up late to learn thoroughly the task set him and to absorb the little more than the required stint of knowledge in which lies success. The men who build bridges and make subways an engineering reality at which the world marvels, great architects, great sculptors, the lawyer who is equipping himself to win a case of national importance, the famous captains of finance—these know that the brain will respond to any strain put upon it. "Force."

Tee Square Champ.

To avoid the trouble of catching the Tee-square every time it slipped when the drawing board was inclined, Henry Hauserman, a student at Central Institute, Cleveland, constructed a clamp, as shown in the sketch.

The clamp has a tail that projects from under the upper edge, and by pressing to the right the force of the spring is reduced and the tee-square slid to the proper position, both hands being used.

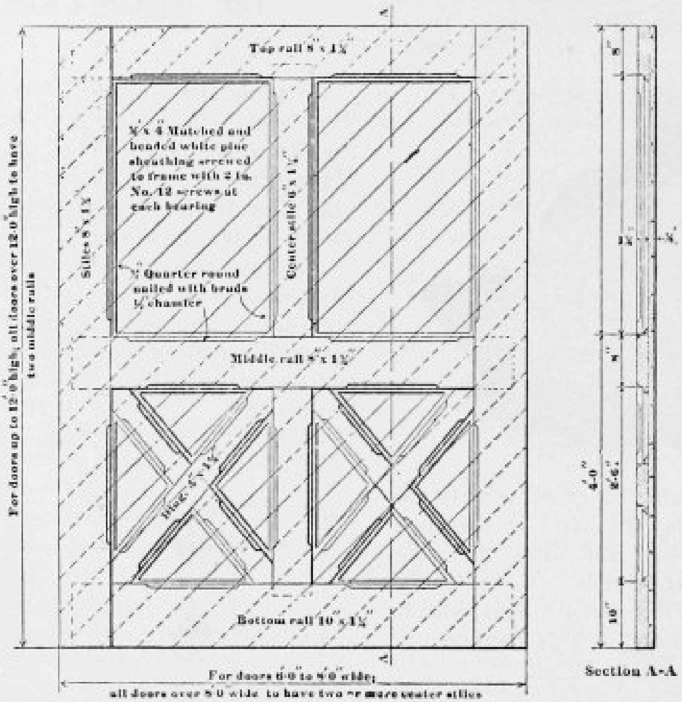


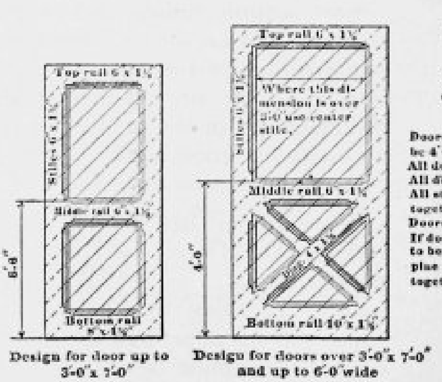
For section lining and when the triangle is to be used for some time in one position of the square, the clamp is a fine thing, since it aids in keeping the right end of the tee-square rigid, a necessity for good work.

Sven Hedin has found, buried in ruins in the Desert of Gobi, Chinese paper that dates back to the third century. According to Chinese sources, paper was manufactured as early as the second millennium before the Christian era.

Ainsworth, Ia.—"Reader"—What is the length of a standard nautical mile?
6,080 feet and 3 1-4 inches.

STANDARD DOOR





Design for door up to 3'-0" x 7'-0"

Design for doors over 3'-0" x 7'-0" and up to 6'-0" wide

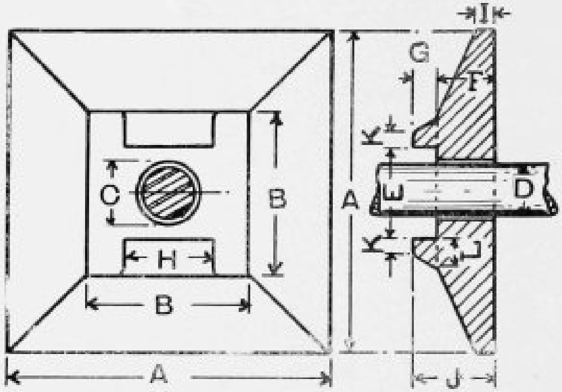
Meeting strips for double sliding doors.

Meeting strip for double swing doors.

Doors may be either slide or swing. Sliding doors should be 4" wider and 2" higher than clear opening between jambs.
All doors under 6'-0" wide to have 1¾" stiles and rails.
All doors over 6'-0" wide to have 1¾" stiles and rails.
All stiles and rails to be halved or mortised and tenoned together.
Doors to be made of white pine
If doors are to be covered with tin or sheet metal they are to be made of two or more thicknesses of ⅞" matched white pine sheathing not over 4" wide, laid diagonally and put together with wrought nails well clinched.

Taken from Book of Standards of Brown Hoisting Machine Co., Cleveland, Ohio.

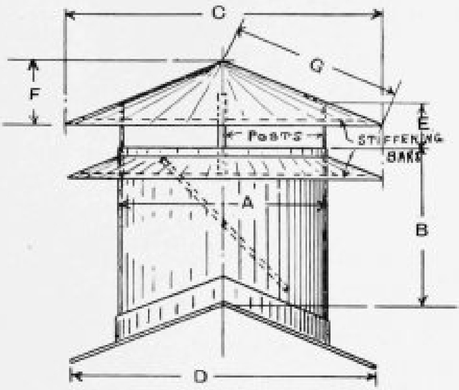
Foundation Anchor Plates.



FOUNDATION ANCHOR PLATES.

D	A	B	C	E	F	G	H	I	J	K	L
1 1/8	6 3/4	3 3/8	1 1/4	1 15/16	1 1/8	9/16	1 13/16	3/8	1 11/16	1/4	9/16
1 1/4	7 1/2	3 3/4	1 3/8	2 1/8	1 1/4	5/8	2 1/8	7/16	1 7/8	5/16	5/8
1 3/8	8 1/4	4 1/8	1 1/2	1 5/16	1 3/8	11/16	2 5/16	7/16	2 1/16	3/8	11/16
1 1/2	9	4 1/2	1 5/8	2 1/2	1 1/2	3/4	2 1/2	1/2	2 1/4	3/8	3/4
1 5/8	9 3/4	4 7/8	1 3/4	2 11/16	1 5/8	13/16	2 11/16	9/16	2 7/16	7/16	13/16
1 3/4	10 1/2	5 1/4	1 7/8	2 7/8	1 3/4	7/8	2 7/8	9/16	2 5/8	7/16	7/8
1 7/8	11 1/4	5 5/8	2	3 1/16	1 7/8	15/16	3 1/16	5/8	2 13/16	1/2	15/16
2	12	6	2 1/4	3 3/8	2	1	3 3/8	11/16	3	1/2	1
2 1/8	12 3/4	6 3/8	2 3/8	3 9/16	2 1/8	1 1/16	3 9/16	11/16	3 3/16	9/16	1 1/16
2 1/4	13 1/2	6 3/4	2 1/2	3 3/4	2 1/4	1 1/8	3 3/4	3/4	3 3/8	9/16	1 1/8
2 3/8	14 1/4	7 1/8	2 5/8	3 15/16	2 3/8	1 3/16	3 15/16	13/16	3 9/16	5/8	1 3/16
2 1/2	15	7 1/2	2 3/4	4 1/8	2 1/2	1 1/4	4 1/8	13/16	3 3/4	5/8	1 1/4
2 5/8	15 3/4	7 7/8	2 7/8	4 5/16	2 5/8	1 5/16	4 5/16	7/8	3 15/16	11/16	1 5/16

Sheet Iron Ventilators,



SHEET IRON VENTILATORS.

Diameter (A)	18	24	30	36	42	48
(B) with Damper	18	24	30	36	42	48
(B) without "	13 1/2	18	22 1/2	27	31 1/2	36
Diameter (C)	27	36	45	54	63	72
Diameter (D)	30	36	42	54	60	66
Height (E)	4 1/2	6	7 1/2	9	10 1/2	12
(F) for 1/5 Pitch	5 3/8	7 3/16	9	10 13/16	12 5/8	14 3/8
(F) " 1/4 "	6 3/4	9	11 1/4	13 1/2	15 3/4	18
(F) " 30° "	7 13/16	10 3/8	13	15 9/16	18 3/16	20 13/16
(F) " 1/3 "	9	12	15	18	21	24
(G) " 1/5 "	14 1/2	19 3/8	24 1/4	29	33 7/8	38 3/4
(G) " 1/4 "	15 1/8	20 1/8	25 1/8	30 3/16	35 1/4	40 1/4
(G) " 30° "	15 1/2	20 3/4	20	31 1/8	36 3/8	41 1/2
(G) " 1/3 "	16 1/4	21 5/8	27	33	37 7/8	43 1/4
No. Posts	4	4	6	6	8	8
Size Posts	1 x 1/4	1 x 1/4	1 x 1/4	1 x 1/4	1 1/4 x 1/4	1 1/4 x 1/4
Stiffeners	1 x 1/4	1 x 1/4	1 x 1/4	1 x 1/4	1 1/4 x 1/4	1 1/4 x 1/4
No. of Iron	18	18	16	16	14	12
Weight of 30° with Damper	76	126	229	307	520	983
Weight 30° without Damper	61	106	191	267	440	760

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

DETAILS OF PROPELLER DESIGN.

CARL H. CLARK.

The general dimensions of the propeller having been determined and the shape of the blade and hub outlined and projected, the details of the design may now be considered.

In a solid propeller it is evident that the size of the hub will be dependent upon the size of the shaft; this does not follow in a built up wheel, where the hub must be great enough in circumference to accommodate the flanges of the blades.

The size of the shaft can be readily figured from the I. H. P. by the usual methods of figuring shafting, using as the effective horse power .80 or .85 of the I. H. P., and a low fiber stress. The end of the shaft fitting into the propeller is turned taper, about $\frac{3}{4}$" or 1' to the foot, being customary; this tapered portion is made slightly shorter than the hub, so that the nut on the rear will always bed fairly on the hub, and not bring up on the end of the taper. The end of the tail shaft is covered with a composition sleeve, shrunk on, to give a bearing in the stern tube and also to prevent corrosion of the tail shaft. This sleeve enters the hub as in Fig. 1, and is carefully caulked and made watertight. The key must be slightly smaller than would be required for a straight shaft, on account of the taper. It is set into a keyway with rounded ends as shown, while the keyway in the hub is cut all the way across. The end of the shaft beyond the hub is turned down smaller than the small end of the taper and threaded, and a nut is fitted to hold the propeller in place. With a right-handed propeller the nut should screw on left-handed, and vice versa. Some efficient means of locking this nut is also to be provided.

The length of the hub is about $2\frac{1}{2}$ to $2\frac{3}{4}$ times the diameter of the shaft, and its diameter, for solid propellers, is 2 or $2\frac{1}{2}$ times the diameter of the shaft. In a built-up wheel, the hub, with the flanges of the blades, is of nearly spherical form. The seats for the blades are counterbored, usually with sloping sides, although they are sometimes bored straight with only a short bevel near the upper edge. The object of the taper is to bring the blade up to a firm bearing, and it must bear on the tapered side and on the bottom at the same time. As will be noticed in Fig. 2 only a ring around the seat is finished, the center being cored out to save weight and labor in turning. Around the bolts which hold the blades in place the seat is enlarged to take them.

The thickness of the blades varies from the base to the tip. This thickness at the tip is a very variable quantity, but will be found to be, for cast iron propellers, from ⅝-inch in a small wheel, to an inch or more in a large one. For composition it will be somewhat less. The thickness at the root of the blade is very largely a matter of experience or very careful calculation. For a fairly close approximation, however, to the results obtained in practice, the taper of the blade may be extended to the shaft center and the thickness measured at that point as shown in Fig. 1 at *T*. This thickness may then be figured as a certain proportion of the diameter of the shaft. A table of these proportions is given below:

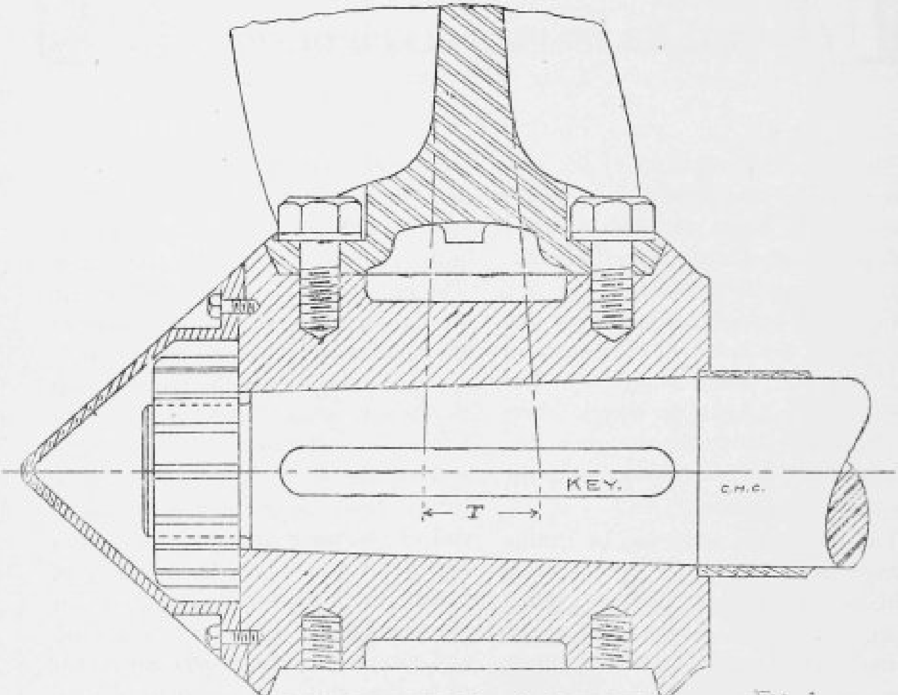


Fig. 1

Solid cast iron wheel, 4 blades, T=.65 diameter shaft.

Solid cast iron wheel, 3 blades, T=.75 diameter shaft.

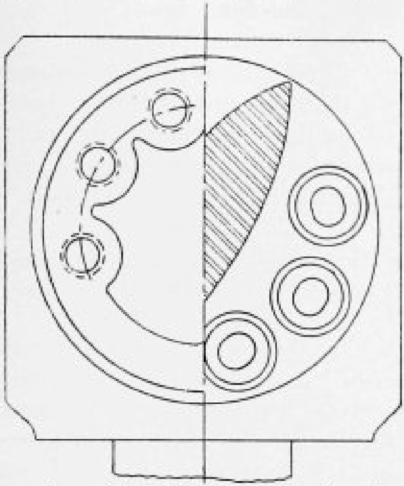
Built cast iron wheel, 4 blades, T=.70 diameter shaft.

Built (bronze or steel) wheel, 4 blades, T=.45 diameter shaft.

Built (bronze or steel) wheel, 3

blades, T=.55 diameter shaft.

It should be noted that the thickness thus found is for propellers of the usual proportions and that for other conditions modifications must



be made. The thickness at the tip does not, of course, mean at the extreme edge, as the edges are rounded off in order to create less disturbance.

The bolts holding the blade in place are from 6 to 10, according to the size. They are seldom less than 2¼ inches in diameter. It will be noted that the holes in the blade are elongated; this allows a slight adjustment of the pitch by turning the blade slightly.

The cap over the nut is of the same material as the hub and is designed to protect the nut and also to give a fair, even surface for the water to pass along, thus avoiding some disturbance. It is carefully turned to fit the end of the hub, and bolted on with tap bolts. The holes around these bolts, and also around the heads of the flange bolts, are filled with cement, to exclude water, and prevent damage.

It is also customary in many cases to fasten a zinc ring on the front face of the hub to prevent the galvanic action between it and the bronze sleeve, or bronze blades, when such are fitted, the zincs being eaten away before the iron is attacked.

What Constitutes a Seamless Tube?

Henry Souther said, in the discussion of this question, that the scientific and technical designation of a tube, whether seamed or seamless, depended solely upon the tube itself, and not upon the process followed in its manufacture. Referring to the dictionary you will find that the word "seamless" means without seam, which conveys no light upon the subject. Turning to the word "seam" it is found that it is defined as a joint, suture, or line of union, and here in the last term we find the key. A tube jointed in any way cannot be seamless. If, in the primary stages of its manufacture, it be lap, butt or lock-jointed, it cannot by any subsequent operation be deprived of the seam, and therefore cannot be considered, when completed, as being seamless. A strictly seamless tube may be made by any one of three operations. First, a billet may be, by successive steps, punched into the form of a tube with extremely thick sides; and these may then, by the ordinary drawing processes, be reduced to a tube with thin walls. Next, the billet may be bored, or the blank may be cast with a hole in it, and in either case then drawn to the required dimensions. Thirdly, the tube may be made by the cupping process, which consists in taking a disk of the metal, forming it into a cup shape, gradually elongating the cup and reducing it in diameter, and finally by this means producing a tube. Each and all of these processes yield a tube which is absolutely seamless and about which there is and can be no dispute. In all tubes formed with a seam the edges have first been separated, then united, either by lap or butt weld, or by some lock-joint system, and in these the joint cannot be eliminated by any after processes. The Custom House of the United States recognizes the difference between a seam and a seamless tube. A seamless tube is one in which the walls have never been separated from the time the metal was in a molten condition to the time of the completion of the tube.

Mechanical Squibs.

Speed of Shafting—

Machine Shops ....120 to 180
Wood Working ....250 to 300
Cotton and Woolen Mills.300 to 400

There are in some factories lines 1,000 feet long, the power being applied at the middle.—From Kent.

Size of Keys—

Width of key=¼ diameter of shaft.

Thickness of key=1-6 diameter of shaft.

Key-Ways—

Depth in hub of straight key-way =½ thickness of key.

Depth in hub of taper key-way=large end=3-5 thickness of key.

Standard taper of all keys=3-16 inch in one foot.

One of the advantages suggested for the steam turbine is the possibility of utilizing its waste or exhaust steam for heating buildings or vessels in which such engines are used.

Screw spikes are in general use in Europe for fastening rails to ties.

One difference between the giant redwood trees of the United States and the giant eucalyptus of Australia is that the redwoods require almost a century to attain any really remarkable growth, while the eucalyptus actually shoots up, growing with a speed that is more typical of a weed than of a tree.

A machine has been invented which is capable of splitting wood two feet long and eighteen inches thick. It is run by a three-horse power gasoline engine, and consists of a huge knife which works through the knottiest wood at the rate of sixty strokes a minute.

The locomotive is expected to go a hundred miles an hour, and exceed in power any steam locomotive on the road, having from 2,300 to 2,500 horsepower, as compared with 1,500 of the fastest passenger engine. The test will begin in a few days. The electric locomotives are to be used in the Park Avenue tunnel.—Troy Special to New York Tribune.

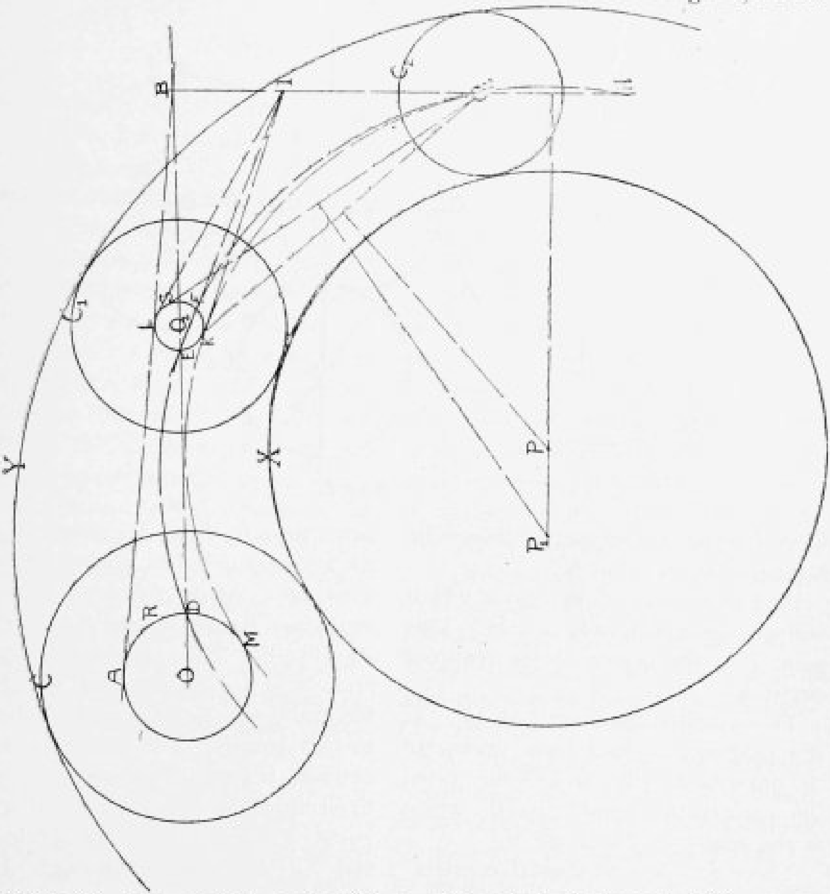
To Draw A Circle Tangent To Three Given Circles.

A METHOD ADMITTING OF A RIGOROUS GEOMETRICAL PROOF.

By A. L. Abbott.

TO THREE GIVEN CIRCLES.

Let the circles be denoted by C, C_1 and C_2, and let C be the largest, C_1 the medium, and C_2 the smallest.



With O as a center, and with a radius equal to the difference of the radii of C and C_2, describe a circle R. With O as a center and a radius equal to the difference of the radii of C_1 and C_2, describe a circle S. Draw AB the common tangent to these two circles; let B be the point in which this tangent cuts the center line OO_1 B; draw BO_2.

Draw a circle through D, E and O_2; this circle intersects BO_2 at some point H.

Draw any circle throug H and O_2 which will intersect either circles S or R. (In most cases the circle which has been drawn through the points

D, E and O_2 will answer without drawing an extra circle.) This circle intersects circle S in the points E and F.

Draw a line connecting these points and produce it until it meets BH at I, perpendicular bisector of KO_2 and a perpendicular to BO_2 at the point O_2.

The above construction will hold good for any position of the circles, whether they intersect or not. If all three circles have their centers in the

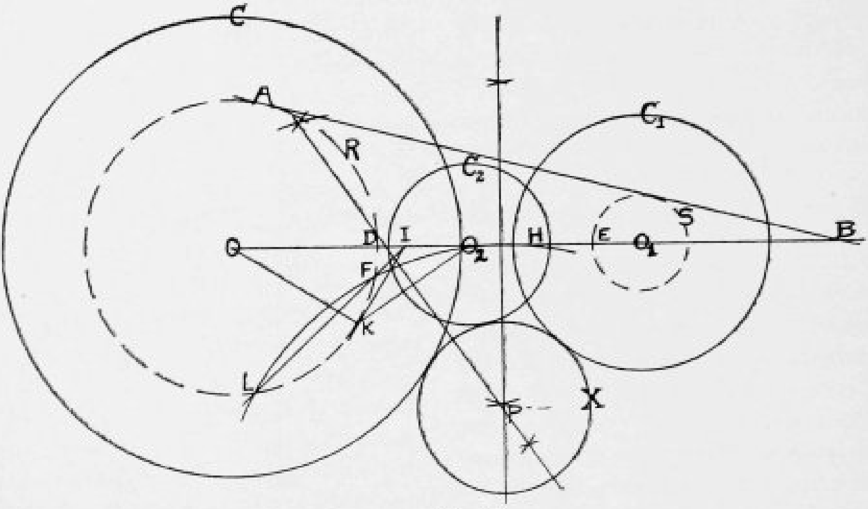


Fig 2

from I draw a tangent to the circle S tangent at the point K.

Find the center of the circle which will go through K, O_2 and H. This point P is the center of the required circle X.

Two Constructions are possible. If the tangent IK had been drawn to the other side of the circle S the dotted line construction would give P_1, which is the center of the circle Y.

There are several special constructions which may be met with, but which can be easily solved with a little thought. For example, suppose circles C and C_1 are equal, then AL will be parallel to OO_1, and consequently O_2B must be drawn parallel to OO_1 also. Again suppose O_2 and H coincide, P would be at the intersection of the same straight line, the point H cannot be determined as above, but must must be done as follows; draw the secondary circles R and S, as before, also the line AB. Measure BD, BE and BO_2. Multiply the length by BE and divide by BO_2, make BH equal to this length. The rest is done exactly as before. The point H can be determined by this calculation for all cases, if desired, then the circle need not be constructed through D, E and O_2.

Fig. 2 shows the construction where circles are in the same straight line. I also drew the circles intersecting to show that it did not affect the results.

(*The first correct solution of this problem was given by Apollonius, a Greek, who lived 200 years B. C.)

STRUCTURAL.

SELF SUPPORTING STEEL CHIMNEYS.

By Wynkoop Kiersted,
M. Am. Soc. C. E.

The practising engineer always welcomes a short and comprehensive formula to aid him in his calculations, and realizes that for the sake of simplicity and ease of application, factors which theoretically belong in a formula may sometimes be dropped without affecting the accuracy of the results derived from a solution of a formula within practical limits. The writer presented a formula of this kind for computing the thickness of metal required in empty standpipes to resist the strain caused by wind pressure, in a paper which appeared in Volume II, of "Selected Papers of the Rensselaer Society of Engineers," June, 1889.

The same formula in a slightly modified form is useful in proportioning the diameter and thickness of metal of self-supporting steel chimneys.

It is $x = \sqrt{F T \div p} = \frac{1}{4} \sqrt{T d t}$ where x is the height of chimney, T is the allowable unit working strain in the metal, F is the area of metal in a horizontal section of the shell, and p is the wind pressure on a unit of surface, or 50 pounds per square foot of plain surface.

The formula may be simplified by substituting numerical values for the several unknown factors, as follows:

F equals π d t when d is the diameter and t the thickness of the metal of the shell. T, the working stress, is dependent for its value upon the strength of the riveted joint. The area of rivets in a well proportioned lap joint is about 77 per cent. of that of a horizontal section of the shell. Assume the available safe shear on the rivets to resist wind pressure to be 7,500 pounds per square inch, less the shear induced by the weight of the shell, which shear by trial is found to be 320 pounds per square inch of rivet section, leaving 7,180 as the available rivet shearing strain, equivalent to 5,528 pounds per square inch of shell section. Hence, $x = 18.6 \sqrt{d t}$. The derivation of the formula is to be found in the paper alluded to and is here given substantially as described 15 years ago.

The conditions for the severest overturning wind strains exist when the structure is empty. The thickness of the metal and the joints should be so proportioned as to be proof against crippling when under strain. The proportions of the structure may be determined by considering it as a semi-girder standing erect, with a static force applied in a horizontal direction equivalent to the force of the wind upon the exposed surface at the usually assumed maximum amount

For sake of simplicity, the weight of the structure may be disregarded, and in the discussion no account is taken of this weight. The general formula for bending moment of a semi-girder, tubular in section, is

$$Pl=\frac{\pi}{4}\,\frac{(r_1^4-r_2^4)}{r_1}\,T$$

where r_1=exterior radius of stand pipe,
r_2=interior radius of stand pipe,
$r=\frac{1}{2}(r_1+r_2)$=mean radius,
$F=\pi(r_1^2-r_2^2)$=area of horizontal section of metal ring,
$t=(r_1-r_2)$=thickness of plate,
T= working strength of metal,
Pl= moment of external force,

$$\therefore Pl=\frac{\pi}{4}\,\frac{[(r_1^2-r_2^2)(r_1^2+r_2^2)]}{r_1}\,T$$

By substitution $Pl=\frac{F}{4}\left\{\frac{2r^2+\frac{t^2}{2}}{r_1}\right\}T=$

$$\frac{F}{4}\left\{\frac{2r^2+\frac{t^2}{2}}{r+\frac{t}{2}}\right\}T=\left\{\frac{4r^2+t^2}{4(2r+t)}\right\}FT=$$

$$CFT=\frac{pdx^2}{4}$$

$$x=\sqrt{\frac{4CFT}{dp}}=\sqrt{C}\times 2\sqrt{\frac{FT}{pd}}$$

where p=wind pressure per unit area or 50 pounds per square foot,
d=diameter of chimney=2r,
x=any unknown height of chimney,
$\frac{1}{2}$x=any lever arm of overturning force; the wind pressure on a cylindrical surface being considered as one-half that on a diametric section.

$$C=\frac{2r^2+t^2}{4(2r+t)}$$

In this value of C it can be readily inferred that t is practically unimportant, and can be dropped. A few mathematical tests will fully demonstrate this.

Hence the value of C becomes equal to $\frac{1}{2}$ r, and

$$x=\sqrt{\tfrac{1}{2}r}\times\sqrt{\frac{4FT}{dp}}=\sqrt{\frac{FT}{p}}=.25\sqrt{Tdt}$$

It is assumed, of course, that the anchorage of the chimney is secure and that the weight of the foundation is sufficient to resist the overturning effect of the wind.

—*The Engineering Record.*

SMILES.

As Always.

"What is your occupation, may I ask?" inquired the passenger with the skull cap.

"Map-maker," said the passenger in the long linen duster.

"Publisher, eh?"

"No. Draftsman."—Chicago Tribune.

HOME STUDY.

Strength of Materials.
Introduction.

This subject is in itself a large one. It will not be possible in this small work to cover the matter in an extended manner.

It is only with a view to acquaint the student with some of the leading points in "Strength of Materials" that the following matter was compiled.

The matter of this series of articles was compiled from various sources, and the writer wishes to give credit to Reid's "Mechanical Drawing and Machine Design," Merriman's "Mechanics of Materials," Goodman's "Mechanics Applied to Engineering," Kent's "Mechanical Engineer's Pocket Book."

The series will treat, first, definitions, general formulæ and tables, then following with strength of screw threads and bolts, cylinders, rivited joints, beams, shafts, columns, etc., etc.

DEFINITIONS.

The *load* of any part of a machine or structure is the total of all external forces acting upon it.

A *live* load is a variable one, applied and removed continuously.

A *dead*, or constant load, is that which has a continuous steady action on the machine or structure.

The *useful* load is that which the machine or structure is designed to carry outside of itself.

Resistance of a material to change its form is due to the inherent cohesive force of its molecules.

Elasticity or spring, is the characteristic of the material to regain its original form after an external load has been removed.

The elastic limit is the maximum extension or compression to which a material can be subjected without permanent set.

Stress and *Strain*—If we were to make any number of sections of a body and it were found that there was no tendency for one part of it to move relative to any other part, that body is said to be in a *state of ease*; but when one part tends to move relative to the other part, we know that the body is acted upon by equal and opposite forces and the body is said to be in a *state of stress*.

Thus, if we were to make a series of saw cuts in a plate of metal and the cuts were found to open or close before the saw was through, we would know that the plate was in a state of stress because the one part tends to move relatively to the other.

The stress is due either to external forces acting on the plate or to internal initial stresses in the material, such as is often found in badly handled castings or in cold rolled shafting.

The strain of a body is the change

of form or dimensions that it undergoes when placed in a state of stress.

If the load does not place the material beyond its elastic limit, the strain will disappear when the stress is removed.

No bodies are absolutely rigid; they all yield, or are strained more or less, when subjected to stress, however small.

A material may be loaded so that the stress will act in one or a combination of forms; if pulling, in *tension;* if pushing, in *compression;* if cross-cutting, in *shear;* if twisting, it produces *torsion*, and the body may be put under both a push and a pull, as in bending.

Then the strength of a material is its resistance to one or the other of these forms of stress: *Tensile* strength, to resist being pulled apart, as a rope; *compressive* strength, as in the foundation of a house; *tortional* strength, as in a shaft; *shearing*, as in the case of a rivet or bolt, though these are often in tension, too.

The cutting of a plate with a pair of shears is a better example of the latter kind of strength.

Bending is a combination of tension and compression.

When the molecules of a body part, it is said to be fractured. A fracture may appear when the load becomes great enough to cause permanent set.

The final, or ultimate strength, is the smallest load that will fracture a member, and machine members should be designed strong enough to resist permanent set under the maximum load.

Stresses are measured in pounds, tons, or kilograms.

A *unit stress* is the amount of stress on a unit of area, and is expressed in pounds per square inch, or in kilograms per square centimeter.

Within the elastic limit, it is found that stress and strain are proportional, and this had led to an investigation to determine some means of concisely expressing the amount of strain that a body undergoes when subjected to a given stress.

The usual method of doing this is to state the intensity of stress required to strain the bar by an amount equal to twice its own length, assuming the *material to remain perfectly elastic.*

It need hardly be pointed out that no material used by engineers will remain perfectly elastic when pulled out to twice its original length; in fact, very few materials will stretch much more than *one thousandth* of their length and remain elastic.

This ratio of strain to stress is known as the *modulus of* (or measure of) *elasticity*, and may be expressed thus:—

$$E.— \frac{\text{Stress per sq. in. in lbs.}}{\text{Strain per inch of length.}}$$

When all is within the elastic limit.

This formula was deduced by Dr. Thomas Young in 1826 and is known as "Young's Formula."

From the above it might be said that the Modulus of Elasticity is the ratio of a unit stress to a unit strain.

The values of the *modulus of elasticity* for different material is given in the table under heading of "Data From Experimental Sources."

When the machine or structure is being designed, we would not want to put on it a useful or working load equal to its ultimate or breaking strength for fear of rupture, but arrange for a certain degree of safety.

This degree of safety is the ratio of the ultimate strength to the working load, and is known as the *factor of safety.*

The factor of safety for a piece to be designed is the ratio of the ultimate strength to the proper allowable working strength.

Thus: If *St* be the ultimate, *S* the breaking strength, and *f* the factor of safety, then

$$f = \frac{St}{S} \text{ and } St = fs.$$

The factor of safety is always an abstract number, which indicates the number of times the working stress may be multiplied before the rupture of the body will take place.

It is evident that working stress should be lower where shocks occur than where a steady even load is applied, hence the factor of safety would be higher.

In a building the working stresses are steady; in a bridge they vary, and the factor in the first case could be small while in the latter much greater.

The following are average values of the allowable factors of safety commonly employed in American practice:

Material.	For study stress.	For varying stress.	For shocks.
Timber	8	10	15
Brick & stone	15	25	30
Cast iron	6	15	20
Wrought iron	4	6	10
Steel	5	7	15

These values are subject to considerable variation in particular instances, not only on account of the different qualities and grades of the material, but also on account of the varying judgment of designers.

They will also vary with the range of varying stress so that different parts of a bridge will have very different factors of safety.

COURSE II MECHANICAL DRAWING.

CHAPTER II.

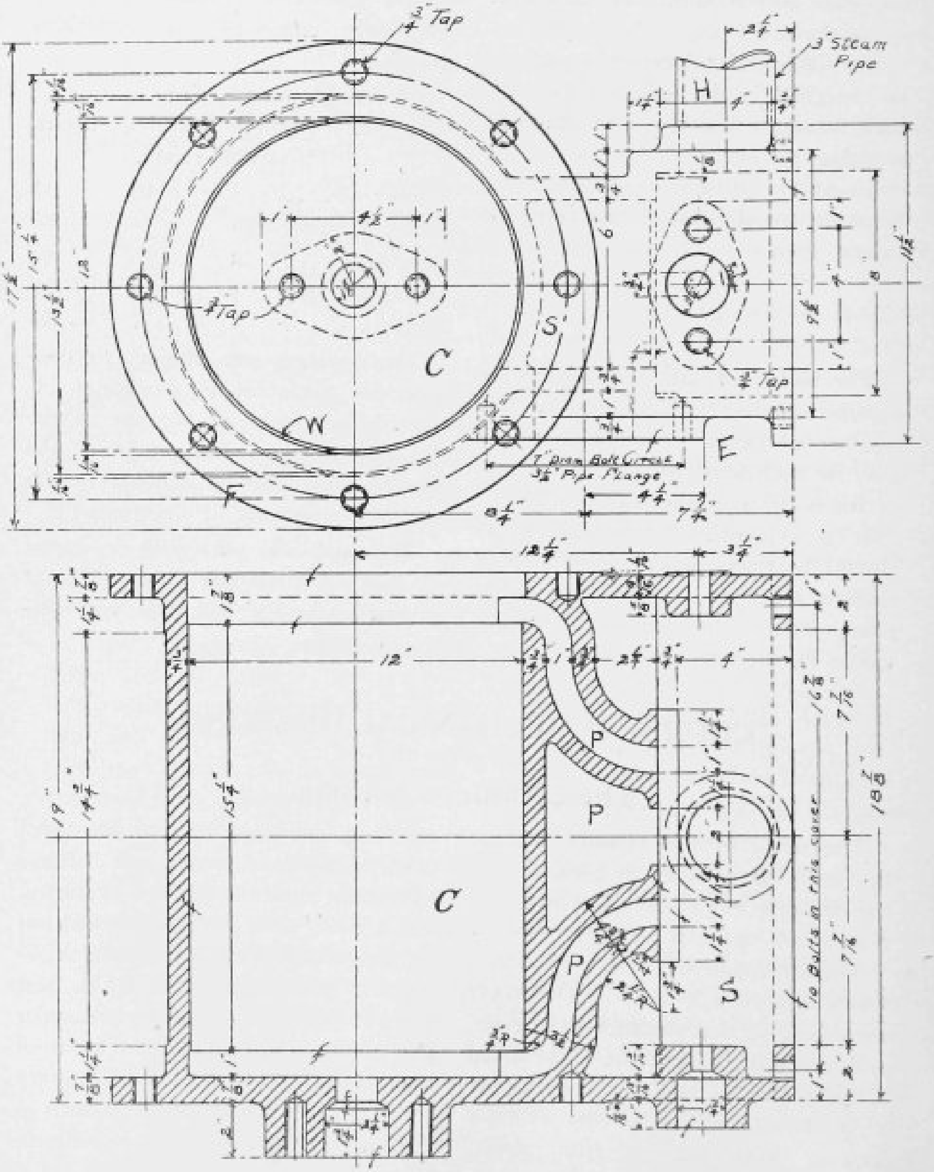
The Cylinder-Castings.

The work of this chapter will be the study of castings in general, and the drawing and calculation of a cast iron steam cylinder.

The accompanying sketch gives two views of such a cylinder. The lower view is a section through the center, and is shown hatched, since the metal is supposed to be cut. The upper view shows the end of the cylinder looking down upon it from above, and laid out according to the third angle method of projection. These two views are to be laid out as shown, and a third view is to be worked out showing the side of the cylinder looking into the steam chest. The best place to put this view is in the upper part of the plate and to the right of the end view. All the data necessary for this third view can be found on the two views given, but it will require some study to work it out.

A large part of a draftsman's time is occupied with such work as this. At first sight it may seem difficult to the learner, but he should bear in mind that it is only necessary to draw one line at a time. Take any line and observe its length and position on each of the views given, and then try to imagine how it will look in the view required.

For example, let the center line of



the third view be a continuation of the center line of the end view in the upper part of the plate. On this center line select a suitable point to represent the middle of the cylinder lengthwise; from this point lay off $9\frac{1}{2}''$ each way, and draw lines through the points so found perpendicular to the center line. These lines will represent the extreme ends of the cylinder, 19 inches apart, as shown on the sectional view given.

Continue in this way with all the other lines in turn.

The following are the names of the different parts of the cylinder referred to in the sketch. *C* is the barrel, *S* is the steam chest, *P P P* are the ports, *H* is the steam pipe, *Ex* the exhaust pipe, *W W* are the cylinder walls, and *FF* are the flanges.

In making this cylinder, a pattern of the outside, and a pattern of the inside, called a core box, has first to be made in wood. These wooden patterns then go to the foundry, where an impression is made of them in sand. This cavity in the sand is then filled with melted cast iron. After it cools off the casting is knocked out of the sand and cleaned up. It then goes to the machine shop, where it is bored out and fitted for use on the engine.

Nothing more than a brief outline of the process is attempted here. Reference books which treat the subject completely are given at the end of the chapter.

CALCULATION OF CYLINDERS

A cylinder will generally fail either by splitting the walls lengthwise or by breaking the cover.

The force which is operating to split the cylinder lengthwise is the pressure on the inside. It is assumed to act as shown by Fig. 1, where *a* is the diameter of the cylinder and the pressure is tending to break it at either end of *a*.

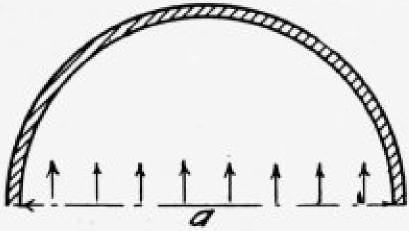


Fig. 1

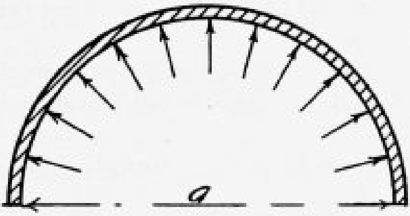


Fig. 2.

The pressure is really acting all around the inside of the cylinder, as shown in Fig. 2. But if we think of the cylinder as splitting from end to end along a straight line, then the force, which will produce this splitting, is the force acting against the projected area of either half as shown by Fig. 1. The force which will resist this stress is the area of the metal in the two walls of the cylinder, multiplied by the strength of the metal per square inch.

Let us suppose that the pressure acting on the inside of the cylinder is 100 pounds per square inch. The cylinder is 10 inches in diameter and 20 inches long. Then the force which will produce rupture is 10x20x100=20,000 pounds (*a*).

The force which is resisting this is (supposing the safe tensile strength of cast iron to be 3,000 pounds per square inch) for the two walls, 20xtx 2x3,000=120,000t (*b*).

If the cylinder does not break *a* and *b* must be equal, that is,
120,000t=20,000
t= .166" (a decimal).

This gives a result which has been found by experience to be entirely too thin for engine cylinders. Allowance is made for bad castings, for reboring cylinders and for possibility of the pressure being run up from any cause.

The following emperical formulas have been found to agree with practice:

(*a*) Whitman's formula $t=.03\sqrt{P.D.}$

(*b*) Van Buren's formula t=.0001-pd+.15$\sqrt{d}$.

(*c*) Barr's formula t=.05d+.3".

t=the thickness of shell in inches.

D and d=diameter of shell in inches (inside).

P and p=pressure in pounds per square inch.

QUESTIONS.

1. Name and describe in not less than 200 words all the operations through which a casting may go from the foundry to the machine.

2. If a pattern weighs 10 pounds what will a casting made from it weigh?

3. Make a table showing the tensile and compressive strength of cast iron, wrought iron and steel.

4. Calculate the thickness of the cylinder on this plate for a pressure of 700 pounds per square inch.

5. Calculate the thickness of a wrought iron water pipe for a pressure of 150 pounds per square inch, using Formula (c) given in this chapter.

MECHANICS.

CHAPTER III.

Speed is the space passed over by a body in unit time. It has nothing to do with direction.

Velocity is speed in connection with which direction is also considered.

If the total space passed over by a body be divided by the time taken, the quotient will be the average space passed over by the body in one unit of time, and this is, therefore, the average velocity.

The fundamental formula connecting space, velocity and time, is

$$S=V_a t. \qquad (1)$$

in which V_a is average velocity for the entire space S. For example, if a train takes four hours to go from one city to another, 100 miles distant, its average velocity is 25 miles per hour, although it may have had several different velocities on the journey.

Velocities are generally given in feet per second, or miles per hour. A convenient fact to remember is that a velocity of 60 miles per hour is equal to 88 feet per second.

Acceleration is the increase in

velocity per unit of time.

Suppose a ball to be placed upon a plane table and put in motion with a velocity of A feet per second; if there were no other forces, such as friction acting upon the ball it would continue moving at this rate forever. Let us suppose, however, that after it has been moving for one second we strike it and add a feet per second to its velocity and continue this at the end of each second; this increase in velocity is called acceleration. It is evident that at the end of one second the velocity of the ball will be a feet per second. At the end of two seconds it will be $2a$ feet per second, and at the end of t seconds it will be at feet per second. In ordinary examples of accelerated motion the force does not act at the end of each second, but acts continuously upon the body; in all cases, however, the acceleration is the total increase in velocity per unit of time. This gives us formula

$$V_t = at \qquad (2)$$

in which V_t is the instantaneous velocity of a body at the end of t seconds which is moving with an average acceleration of a feet per second.

Evidently, a body moving with an accelerated motion has a different velocity at each instant, and before we can find the space passed over by such a body we must get the average velocity for the entire distance. If the acceleration or increase in velocity is uniform the average velocity is equal to one-half the sum of the initial and final velocities; if the initial velocity is zero, that is, if the body starts from rest with an accelerated velocity, the average velocity is one-half the final velocity, or $\frac{1}{2}\,at$, and consequently the space passed over in t seconds is obtained by substituting this value of Va in formula (1), giving

$$S = \tfrac{1}{2}at^2. \qquad (3)$$

If we consider equations (2) and (3) as simultaneous equations and eliminate t we get

$$V_t^2 = 2as \qquad (4)$$

If an accelerated body did not start with an initial velocity of o, but with a velocity of u formulæ (2), (3) and (4) become respectively—

$$V_t = u + at. \qquad (5)$$

$$S = ut + \tfrac{1}{2}at^2. \qquad (6)$$

$$V_t^2 = u^2 + 2as. \qquad (7)$$

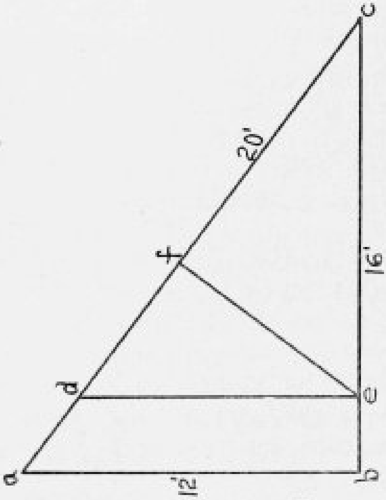
The working out of the last three formulæ is left as an exercise for the student.

Retardation is the opposite of Acceleration. It is the *decrease* in velocity in a unit of time. The formulæ for accelerated motion apply for retarded motion by taking into account the fact that retardation is negative acceleration.

The most common form of accelerated motion met with is that of falling bodies. When a body falls freely, there is the attraction of gravity acting continuously upon it, giving it an acceleration or constant increase in velocity. The approximate acceleration due to gravity is 32.16 feet per second.

A special case of falling bodies is that of a body moving down an inclined plane. Let ac be an inclined plane with the dimensions in feet as shown. Assume a ball to roll from a

to *c* without friction; draw *de* to represent to scale the attraction of gravity *g*, resolve this into two components, *d f* parallel to the plane and



e f perpendicular to it. Then the acceleration acting upon the ball as it rolls down the incline is represented to scale by *d f*, but triangle *def* is similar to triangle *abc*, therefore $\frac{df}{de} = \frac{ab}{ac}$ or $df = \frac{12}{12\text{-}20}$ of $32.16 = \frac{3}{5g}$.

Then the velocity of the ball when it arrives at the point *c* is found by substituting in formula (4)

$$V_1^2 = \frac{6}{5} g\ 20 = 24g$$

or

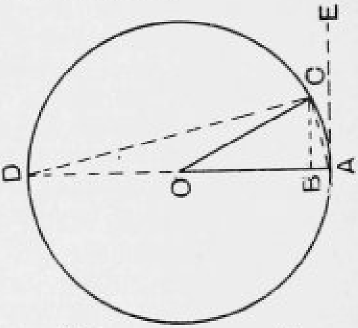
$$V_1 = \sqrt{24g}$$

Now, suppose the body had fallen from *a* to *b*, the velocity at *b* would be found by substituting in the same formula, but the acceleration in this case would be *g*, then

$$V = \sqrt{2g12} = \sqrt{24g}.$$

Apparently, then, if friction is neglected the velocity attained by a body in going from one elevation down an inclined plane to a lower elevation is the same as that attained by a body in falling through the same difference in elevation.

Centrifugal Force.—Suppose a body to be revolving about the fixed point *O* with a *constant* velocity and let it be attached to the point *O* by a string *O A*; the body is then said to have a constrained motion.



Let *AC* be a very small arc of the path, then without sensible error the body can be considered to move from *A* to *C* along the chord instead of the arc. If the body were detached from the string at the point *A*, it would move along the tangent *A E*, but since it is not free to move along *A E* it follows the path of the circle and in going from *A* to *C* it is drawn out of the path it tends to take by a distance *AB*.

Let the velocity of the body in the circular path be represented by *V* and let t= the time to go from *A* to *C*, and let *R* be the radius of the circle. Then from geometry $AC^2 = AD \times AB$. Now *A C*, being the distance passed over by a body moving with a constant velocity, is equal to *V t* and

$AD = 2R$, therefore, $AB = \frac{V^2t^2}{2R}$, but AB is the space passed over by a body moving with an accelerated motion and it is therefore equal to $\frac{1}{2}at^2$, then $\frac{1}{2}at^2 = \frac{V^2t^2}{2R}$, or $a = \frac{V^2}{R}$, that is the acceleration along the radius caused by the pull of the string is $\frac{V^2}{R}$; since elementary physics tells us that Force = Mass × acceleration, the force pulling on the string $= \frac{MV^2}{R}$. This outward pull on the string is called centrifugal force (C. F.)

Substituting W for M gives

$$CF = \frac{WV^2}{gR} \quad (8)$$

in which if W is in lbs., V and g in feet per second and R in feet $C. F.$ will be given in pounds.

Since $C. F.$ is used largely in mechanics, and since the velocity of revolving bodies is generally expressed in revolutions per minute (r. p. m.), we will derive another formula for such work. Let N be the r. p. m., then $\frac{2\pi RN}{60}$ is the velocity in feet per second, substitute this value in (8) gives

$$C. F. = .00034\ W\ R\ N. \quad (9)$$

Problems.

1. Niagara Falls is 164 feet high; how long does it take the water to fall over the falls, and what is the velocity attained at the bottom in miles per hour? Ans.—3.194 sec., 70 m. p. h.

2. A meteor falling vertically was observed to fall 1,608 feet during the 1-10 of a second preceding its striking the earth. How many miles high was it when it started to fall, considering it a freely falling body and having been acted upon by g=32.16 ft. per sec. during the entire distance? Ans.—761.5 miles.

3. A cannon is on a fort which is 10 feet above the surrounding plane, it is fired horizontally with an initial horizontal velocity of 1,300 feet per second, which velocity we will consider constant during the entire flight. How far did the ball go? Ans.—2,050.6 ft.

4. A car starts from the top of a slope 3,000 feet above the surrounding country, the length of the track from the top to the lower level is 30 miles, neglecting friction, how long will it take the car to arrive at the bottom, and what will be its velocity at the bottom? Ans.—12 min., 1.3 sec.; 299.46 m. p. h.

5. A skyrocket took 7 seconds from the time it left the ground until it returned; how high did it go? Ans.—196.98 feet.

6. A boy threw a stone into a window. The stone was in the air two seconds; how high was the window? Ans.—64.32 ft.

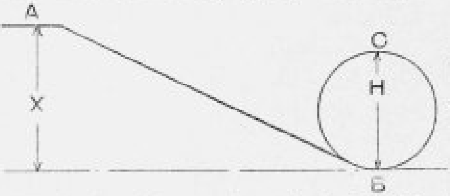
7. What must be the initial velocity given to a rifle ball to make it rise one mile in the air if fired directly upwards? Ans.—582.76 ft. per sec.

8. A body had been moving with a uniform velocity of 40 feet per second, it was then acted upon by a constant force which is capable of giving it an acceleration of 25 feet per second. What will be the velocity of the body after it has moved 96 feet under these new conditions? Ans.—80 ft. per sec.

9. In problem 8, how long did it take the body to move over the 96 feet,

and what was the average velocity for that time? Ans.—1.6 sec., 60 ft. per sec.

10. In a loop-the-loop machine a man with a bicycle starts from the platform at *A*, rides down the incline and develops speed enough to carry him around the loop at *B*. The man



and wheel weigh 200 lbs., the height *H* is 30 feet. What must be the lowest height *X* which could be used, neglecting friction? Ans.—125 ft.

11. A smooth glass inclined plane and ball were used to determine the value of *g*; the plane made an angle of 30° with the horizontal. The average of several trials gave the following result: When the ball was liberated at the top it passed over the first 10¼ feet in 1¼ seconds. What was the value of *g*? Ans.—32.39.

12. A train weighing 24 tons is running at the rate of 60 miles an hour on rails 4 feet apart; it rounds a curve of radius 3,000 feet: (*a*) What is the pressure on the flanges of the wheel if the rails are both the same level? (*b*) How much higher should the outer rail be in order that no pressure should be exerted upon the flange? (Consider no friction.)

Ans.—(*a*), 3,852.7 lbs., (*b*), 3.84+ inches.

In the matter of book publications Russia is at the foot of the list of nations.

A new explosive, which is called ammonal, has been made from powdered aluminum.

Cement is being used instead of wood for piles. They are made in triangular shape, and are driven in the same manner as those of wood.

To dock, scrape and paint one of the British ironclads costs an average of $20,000, and this has to be done twice a year.

Copper mines in Michigan have increased in number from less than 7,000 in 1893, to more than 14,000 in 1903.

Sunflowers make good fuel. The stalks when dry are as hard as maple-wood and make a good fire, and the seedheads, with the seeds in, are said to burn better than the best hard coal.

The great Corliss engine that furnished the power for the Centennial Exposition at Philadelphia had 300 horse power. At St. Louis one engine has 8,000 horse-power.

Greece is overrun by well educated men who do not know how to earn a living. The country swarms with doctors who have no patients and lawyers who have no briefs, while laborers to till the soil are at a premium.

CURRENT TOPICS.

Why Learn Drawing?

By D. Eldred Wood.

Few people realize what it means to possess a knowledge of drawing, and to be able to utilize that knowledge at pleasure. It has long been a belief among many people that one must have a natural ability in order been exploded by the introduction of to be able to draw. But this idea has drawing into the curriculum of study in the public schools all over the country. The progress which nearly all students make in the study of drawing in school shows conclusively that it can be learned, in just the same manner as music, geography, arithmetic, or writing. True, some students excel in drawing the same as in all other studies, but that does not of necessity prove that they have more natural ability for one study than another. It is usually because they devote more time to that particular study because they like it better than they do the others.

A knowledge of drawing is of more practical value to every one than almost any other line of study. For instance, if one wishes to explain to some one else, perhaps a foreigner, or some one who is unable to "catch the idea" as you see it, a few strokes of the pencil or pen, by way of illustration, makes it all clear. It is done in one-third the time and with much less effort than it would take to write it or explain the same thing in words. Drawing comes the nearest to being a universal language of any art at the present time, as people of all nationalities readily see the things expressed in drawings.

Then another thing, the person who can draw, even if he knows but a little about it, will see things all through life which otherwise would pass unnoticed. Why? Because people learn by seeing. The great majority of people have never been trained to properly see how a thing actually appears. This is the kind of training the study of drawing will give you. Did you ever write out a word to see how it looks, when you were a little uncertain just how to spell it? Somebody may tell you how a flower or tree looks, but you can't know so much about it as you can by "taking a look" at it. If you know *how to draw* you see more of the details and beauties with which everything in nature is surrounded.

We all think we know how a cat or dog looks, but few of us can make a drawing of either one. Our efforts would probably look about as much like one as the other, and the only way our friends would ever know what it was would be for us to mark it in plain letters "this is a cat" or "this is a dog." The reason why we can't do this is not because of any lack of natural ability or talent, but because we have never noted the distinguishing features of a cat or a dog —never seen them as they really are.

We all know how our mother, father, sister or brother looks, but for the life of us we couldn't draw a picture which would be a recognizable likeness, because we never looked at them from an artist's standpoint, or with a thought of their distinguishing features.

And right here consider for a moment what an accomplishment it is to be able, when one is out in a company of friends, to sit down and draw a likeness of some one of them, or even draw pictures from memory or imagination. The whole company would be asking the privilege of watching you while you are at work. They marvel at the way expression is brought out, is changed from good to bad, sensible to senseless, from old age to youth, by the simple changing of a few lines, sometimes one very small one. They will stand for hours and watch a person draw and idolize him when he is through. By doing just a little practicing in this way the artist has no difficulty in becoming "the lion of the hour." He places himself in the front ranks of society, which ever stands ready to bow in humble submission at his feet. Why? Because they all know that while he may—while in their presence—put in the beauty lines in making a picture of them, he can, and just as easily, because he knows how, use others which will place them in an uncomfortable light, to say the least.

The artist becomes, as it were, a ruler of men. He wields a most powerful influence over people, and is a recognized factor in molding public opinion, even to shaping the destinies of nations, and the building of worlds.

Look at the great men in the field of commercial newspaper art today—such men as Fred Opper, John T. McCutcheion, George Busch, Davenport and Charles Dana Gibson. The late Hon. Marcus A. Hanna once said that there was only one man of whom he was afraid and that was Davenport, cartoonist for the New York Journal, because he said there was nothing he could do but "grin and bear" the caricature drawings which were made of him. We are all familiar with the society cartoons of Gibson and others, and anyone can at once realize what a potent factor these men are in picturing the national and international events of today and shaping men's minds in conformity with the policies of the "powers that be." It has also been said that political office-seekers dread the artists and illustrators as much, or more, than anything else, for if they have ever made a mistake in their lives it is sure to become known and then the "molehill" is changed into a "mountain" through the magic pen of the artist.

Such, then, are some of the possibilities before the person who can draw, to say nothing of the pleasure and satisfaction derived from presenting our friends with a piece of our own handiwork. We all know how much more a present is appreciated if it represents a certain amount of our friend's own labor. We cherish it as a keepsake and when occasion offers usually find some way to return the kindness in the same manner.

And besides all this there are possibilities and opportunities for making those "delightful poetic transcriptions of nature." When one goes on a tour or travels into new or strange places, how many of us have wished, time after time, for the artist's ability—to reproduce, to save from total oblivion, except in memory, to preserve for future enjoyment, some tender and suggestive record of a judiciously selected landscape subject, an exquisite sunrise or sunset, a charming forest glen. Oh, for a general artistic equipment capable of rendering with dignified effect these picturesque effects. Such work, when brilliant in handling and elaborately finished without excess of labor, has an air of spontaneity which makes it extremely persuasive. And in no other way can one give expression to poetic ideas so vividly as by the art of drawing.

My young friends, learn to draw. It means more to you than anything else. Study the works of artists and draftsmen along the line of your inclination. Read the best publications devoted to the interest of those who wield the pen, crayon or brush. If you desire to follow some branch of art as an occupation, indeed as a profession, there is good money in it; there is plenty. The field is not crowded at the top, where you can certainly be if you have the true desire, the ambition and the aspiration to achieve.

Our Rapid Age.

Mr. Dwight L. Stoddard, in his *Steel Square Pocket Book,* says:

"A quarter of a century ago, although mechanics worked longer days than today, yet they seemed to have plenty of time to walk, or ride with an ox team to their work. And they thought they were going at a great speed if they rode in a car drawn by a mule. But today they must go at a breakneck speed on a bicycle, automobile, or as fast as electricity can carry them.

They used to work by the day. Now they work by the hour, and the time seems near when they will work by the minute, and every *minute* must count.

"Think of putting in a time card with 480 minutes for an eight-hour day. If one was late in the morning, say fifteen minutes, it would be deducted from the above.

"It would come to a point where the careful workman would soon acquire the habit of having his hammer in the air waiting for the first tone of the whistle, and if it was raised for a stroke when closing time came he would leave it there, that is, if the atmosphere was thick enough to hold it till morning.

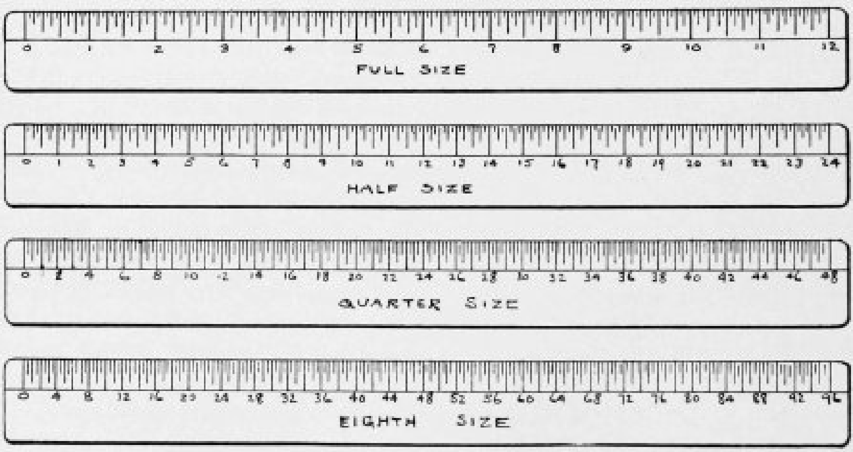
"The draftsman would leave his pencil standing at a point against the scale and he would soon acquire the habit of not looking up from his work during the day. Alas! we regret that such a future is before us. It will no doubt make some of us old to think about it, or cause us to change to a climate where the sons of toil do not hustle quite so much."

Drawing Scales.

The subject of drawing scales has certainly had devoted to it its share of articles, but as every engineer and draftsman has ideas of his own about scales, I would like to express mine.

As sixty and seventy-two-inch rules, graduated in inches, have so universally taken the place of the old style two and three-foot rules, a drawing scale or set of scales to conform with same should be had. The architects' scale, as commonly used by mechanical draftsmen, was very good some time ago, when dimensions on drawings and sketches were in feet and inches, thus, 4'—7", but now, as it is more practicable to put same dimensions on in inches, thus, 55", it would be handier if a person had a scale graduated in inches the entire length of same, called a full divided scale. With such a scale a draftsman would not have to calculate mentally what dimensions in inches corresponded to one in feet and inches and then change it back again when he places the dimension upon the drawing. Then comes the checker, who also would find the same convenience in an inch scale. Time now wasted in going over figures to be sure of them would be saved, and also fewer mistakes would be made.

Accompanying sketch shows cuts of scales which would be most common to mechanical draftsmen. I would suggest that the scales, four in number, full size, half size, quarter size and eighth size, would be separate and having one edge only graduated. They may be made either flat or triangular, as the draftsman deems best adapted for his work. The flat scales are very handy for reading dimensions from drawings or blue prints, but for accurate drawing a metal triangular scale is better because a prick point can be used to good advantage.—H. MacDonald.



A Letter.

Nephew Dan:

In reply to your letter relative to the drafting business, will now answer somewhat more at length.

You ask: First—What is the work like, or of what does it consist? Second—What should one's education be to insure success, or, more specifically, what studies should you pursue in the junior and senior years of your High School course?

To the first I will say in general that drafting is the written language of construction.

Drawings are of two general varieties—picture drawings, which belong more to the domain of the artistic, but show, in a general way, the appearance of the construction, and working drawings, which give all the information necessary to make whatever they are drawings of. It is this variety that the draftsman usually deals with, and it is his business to make them as clear, concise and complete as possible, artistic ability cutting but a small figure except in some classes of work, such as monumental work, art structural work, or decorative work of various kinds.

For instance, you wish a table made; you have a picture of a table just like you want it; you put some figures on the picture, giving the sizes of the parts and say what sort of wood, what sort of finish, etc., and it becomes a drawing, and when sent to the carpenter shows him just what you want made.

Suppose the one in charge gives you a rough sketch of a table, telling you how he wishes it to be made, gives you sizes, etc., and looks after your work from time to time. You make a drawing for it and might be called a draftsman, in so far as this particular case is concerned, but you are only a *copyist draftsman.*

Again, suppose a table is needed for some particular purpose. You make a drawing of a table to fit this purpose, taking into account size, material, method of putting together, what facilities the one who makes it has for doing the work, keeping uppermost in mind the purpose for which is it intended and not making it cost too much or yet be a poor job; taking hold of existing conditions, whatever they may be, and striking a happy mean whereby you accomplish the desired result in the best manner. You are now a designer, or at least a *designing draftsman.*

Any draftsman, to be of much value to a concern manufacturing anything or doing engineering, must be to some extent a designer. It is an easy matter to learn how to draw, but to know what to draw, i. e., have good ideas of how to make things, is not so easily learned and only comes to one by practical experience. In the case of the table: You may know about how large to make the various parts in order to have a good strong table, but if it were a bridge or a crane you were building, the parts would have to be calculated for strength.

The draftsman usually starts in as a tracer, i. e., he inks in other people's drawings on transparent cloth, called tracing cloth. He thus learns how things are shown and "catches on" to many ideas about how things are made. As he advances, he makes drawings himself, mainly copied from other drawings with changes, and gets more ideas, and commences to work in ideas of his own.

When he has enough ideas of his own, so that he can take hold of a general scheme and get out the details in good shape, he is a draftsman. He may only be a detail man, but in some classes of work a good detailer is a pretty good man.

A draftsman is both a student and an instructor. He is always studying his work and the work of others, and is always instructing his fellows who have not studied or worked on what he has. The drafting room is necessarily a school of construction.

As to the education necessary. Few men in the business have the preliminary training they ought to have, and yet too much theory and too little practice are not looked upon favorably. A university course is not a necessity, but would be a very decided advantage. A good High School education would make a fair foundation upon which to build. Of the languages, German would come in handy, as many technical works not translated are written in that language, but is not essential. Mathematics and physics are the backbone of the constructive sciences. Calculus is seldom used in the drafting room, although it is used very much in the theory of mechanics. One can get along very well without it and do good work when they understand the ordinary geometric propositions and are able to solve a triangle.

Of physics one should understand thoroughly all that is taught in the ordinary textbooks. The parts upon which it will be necessary to enlarge later will depend largely upon what line of drafting the student enters.

Draftsmen are one section of that large class who do something with their hands and brains for a livelihood. They employ their brain fat in developing constructions which add to our convenience, or safety, or are otherwise necessary or desirable. Latin, Greek, art, literature, fashion, society and politics are only side issues with them.

A doctor operates upon a patient for appendicitis when Rochelle salts would have been more to the point. The man dies. The doctor worked hard with him, but the man's time had come, so say the people. A lawyer defends an innocent man, but he is hung. Twelve good men, tried and true, found him guilty, so the people say it is so. The lawyer had a bad case, he did all he could. A minister may drive the young from the fold by preaching ten-yard faces, hell fire and brimstone, work in the vineyard, but take no amusement, and he is a zealous man. But let a structure fall and see how soon the engineer's reputation is blasted. He deals with the immutable laws of nature, be they known or unknown. And when failure occurs it is "up to him."

Your Uncle Jack.

Lettering.

By Prof. A. Edward Rhodes.

It is desirable to confine the lettering of drawings to one or two standard alphabets that are plain and distinct, and the principles of which are easily acquired. These conditions are fulfilled in the letters shown in the accompanying plate. These letters may be made free-hand or with instruments. Lettering is easily learned if the shape of the letters is first fixed in the mind of the student. This is most readily done by comparing the various letters composing the lower case alphabet. (No. 3 on the plate.) The basis of the letters in this alphabet is a circle.

a is a circle with a vertical line added to its right side.

b is a circle with a vertical line added to its left side.

c is about three-fourths of a circle, open at the right side.

d is like *a* except that the vertical line is longer.

e is like *c* with the addition of a horizontal line across the interior.

f is like a cross with the addition of a small curve at the top.

g is *d* inverted. The lower end of this letter may be curved to the left as shown.

h is like *b* except that only the upper half of the circle is used and that the right end of the semi-circle is continued vertically to the guide line.

i is simply a vertical line with a dot above it.

j is about three-fourths as wide as the diameter of *a*.

k consists of three straight lines, the longest one a vertical, the others at 45 degrees with it.

l is simply a vertical line.

m consists of the upper halves of two tangent circles, and those vertical lines.

n is the left half of *m*, it also is like *h* with the top of the stem removed.

o is simply a circle. It is the basis of all the curved letters.

p is *b* inverted.

q is like *g*, excepting that the curve at the bottom is turned to the right.

r is the left half of *n*.

s consists of the upper and lower portions of the base circle, and of a reverse curve joining the left end of the upper with the right end of the lower portion.

t is *l* with a horizontal line three-fourths as long as the diameter of *a* and even with the top of the curved letters.

u is *n* inverted and reversed.

v is two lines meeting at their lower extremities and making equal angles with the horizon.

w is two v's placed side by side and touching at the top.

x is two lines inclined at forty-five degrees and intersecting at their middle points.

y has the right vertical line of *u* produced down and ending in a curve like *g*.

z consists of two horizontal lines, and an inclined line connecting them.

CAPITALS, OR UPPER CASE ALPHABET.

These letters and figures, like the lower case letters, are based upon the circle and are self-explanatory.

Beginners never can letter well, and it is necessary that they devote considerable time to practicing lettering before attempting to letter or dimension a drawing, for no matter how well the views may be drawn, if the lettering is poorly done the finished drawing will not have a neat appearance. No draftsman can letter as rapidly as he can do ordinary writing. Very frequently more time is spent in lettering a drawing than in inking in the views of the object represented. The importance of good lettering *cannot be over-estimated*.

Large letters, like those shown at 1, 2, 3, 4, 6 and 7, may be made with the instruments. The small and inclined letters, like 5, 8, 9 and 10, are made free-hand, using first a round-pointed pencil and then an ordinary writing pen.

When making freehand letters *always* draw at least two horizontal guide lines, and if the least trouble is experienced in making the stems of letters parallel, draw guide lines for the stems. Great care should be exercised to get all horizontal lines horizontal, all vertical lines vertical and all inclined lines parallel.

The guide lines are for limiting the letter to its exact size, therefore, when a line should meet a guide line make it do so, but do not leave it project beyond the limiting guide line.

Blue Printing.

By Fred D. Foss.

Having received a letter from a prominent architect of Omaha, asking for a formula for making "blue print paper and instructions for developing the same," I will allow the intended continuation of the articles on hydrochinon development to lapse and comply with the request, giving several formulas for working the process, and also the formula in use by myself.

Perhaps a few preliminary remarks may lead to a clearer understanding of the action of light upon paper sensitized with iron salts, so as the result of Sir John Herschell's investigations will be given. "The double citrate of iron and ammonia is more readily acted upon by light than any of the other iron salts, the double oxalate of iron and potassium ranking next. (Printing with the latter has only an experimental value, so it will not be treated of in this article.) The law upon which the process of printing with salts of iron is based is that the ferric salts are by the action of light reduced to the ferrous salts, which are capable of being acted upon by various toning agents, such as potassium ferrocyanide, chloride of gold, platinic tetrachloride, mercuric chloride, potassic bichromate, cupric chloride, and others. The developing solution most commonly employed is potassic ferrocyanide, and for its use two methods are adopted, one being to coat well-sized paper with the solution of the iron salt, dry, print, and tone on a solution of potassic ferrocyanide. The other and more convenient method is to coat the paper with a mixed solution of iron and ferrocyanide, and to fix the print in water. Should the first method be chosen, the following way may be adopted:

Citrate of iron and ammonia......
.... 154 grains
Water (distilled) ....25 drams

Apply this solution to the paper with a brush or sponge, or float the paper on it from one to three minutes. When dry, expose under the negative until a faint image is visible. For a blue print, immerse in a solution of potassium ferrocyanide one to ten (potassium ferrocyanide one ounce, water ten ounces). When the image is fully developed or toned, wash thoroughly in water, adding a little citric or acetic acid to the first wash water. This will dissolve out all the soluble salts and leave the blue image unchangeable. If a purple image is desired, immerse the print in a neutral solution of chloride of gold (gold, 1 grain; water, 4 ounces: to which is added a few drops of saturated solution of bicarbonate of soda). The reduction of the gold takes place according to the law that the ferrous salts reduce salts of gold to the metallic state. To fix the pictures, they are immersed in a bath of dilute hydrochloric acid and then thoroughly washed in water. This process gives the once famous chrysotype. Other tones may be produced by immersing the prints in a very dilute solution of platinic tetrachloride, mercuric chloride, cupic chloride, or potassic bichromate of about the same strength as the gold solution mentioned above, always using the acid bath, followed by copious washing. These methods give very pleasant results and are worthy the attention of architects who desire to reproduce their plans or drawings. Pure chemicals, water and paper should be used if permanency of prints and good results are desired. Longer exposure will be found necessary with the salts of gold, platinum, etc., than when the ferrocyanide is employed. An interesting method of developing prints for paper prepared with the double salt of iron and ammonia is to float on a forty-grain solution of silver nitrate, to which a few drops of gallic acid or acetic acid have been added. The silver nitrate is reduced to the metallic state by the ferrous salt, and the metallic silver is deposited where the ferrous salt was present. The gallic acid causes a further reduction of silver, and an image in metallic silver is formed, which is presumably permanent. We now come to the more usual method of using the citrate of iron in conjunction with the ferrocyanide, thus uniting sensitizer and developer. This process has simplicity to recommend it, and when at its best gives very charming results. But to insure the highest degree of excellence in blue prints, the following points must be carefully attended to:

1. The chemicals should be of the best.

2. The paper must be free from deleterious matter.

3. A few grains of bromide of potassium should be added to the mixed solutions to confer greater keeping, however, to the paper and to add to the density of the prints.

4. The first wash water should contain a little citric or hydrochloric acid, and the after washings in plain water should be most thorough.

5. The paper must be sensitized in a dim light—gaslight is safe—or pure whites will be unknown.

6. The paper should be sized. Albumen coagulated by heat is undoubtedly the best sizing, but the following arrowroot sizing will be found good: 154 grains of arrowroot rubbed up with cold water, then poured into 25 ounces of boiling water, and 6 ounces of alcohol added. Float the paper on this solution for two or three minutes, and suspend to dry by the end which left the solution last, in order to equalize the coating. Plain sized paper can, however, be purchased from Douglass' photographic stock house, which will answer all purposes. Good blue prints

can be made without attention to these details, but all the capabilities of the process will show themselves only when they are observed, and bear in mind the old maxim: "What is worth doing is worth doing well." —Inland Architect.

According to La Nature a new compound of water, albumen, sulphate of magnesia, alum, sulphate of Calcium, roasted, and borax, the mixture being called calxia, is destined to displace terra cotta and plaster in the majority of their uses, especially in making small articles and covering small surfaces. The advantages claimed for the new substance include lightness and power of resisting shocks which would break terra cotta. It also has a very high degree of imperviousness to hot and caustic solutions. Finally, according to La Nature, the process of manufacture can be carried out by anyone, though there must be care to make it exactly correct, and the cost is only about half as great as that of terra cotta.

A Trade Prophet.

The remarkable manner in which the trade conditions, which have prevailed thus far during the present year, were foretold last December by Samuel Benner, a farmer of Dundas, O., has created a great deal of comment among the manufacturers of the country, particularly the steel men, who have for many years given much weight to the prophecies made by the Buckeye farmer sage.

For many years Benner has been announcing, a year ahead of time, the trend of trade, basing his prediction on the proposition that periods of finance and trade move in cycles and that, having once learned from the history of the past the duration of the cycles, it was the easiest matter to foretell the probable course trade and finance would pursue in the future. He covers the conditions of steel, iron, grain and provisions, and has been so remarkably successful that the steel men watch the predictions with great care.

Benner lays no claim whatever to supernatural power, basing his predictions solely on the lessons of the past. The late Addison Cammack, one of the greatest speculative traders in the history of Wall street, watched the predictions for many years and during the later years of his activity in the market was guided solely in his transactions by the predictions of the old man. During the early 90's it was the prediction of Benner that a cycle of high prices had come that induced Cammack to undertake his campaign which netted him over $4,000,000. He believed Benner had gained a foresight into the economic laws governing the world of trade.

Last December, when Benner gave out his predictions for the present and the coming year, he gave a forecast of what has happened in a most complete manner, so much so that the predictions have been reprinted and are in circulation among the traders of Wall street, who are following them more than most of them care to ad- Benner predictions are as follows:

"I predict that prices for pig iron, railroad stocks and many commodities will be lower in 1904 than in 1903.

"I predict that after the year 1904 there will be a revival in trade, better times, and that higher prices will prevail until the year 1911.

"The present down cycle in prices and in general business ends in 1904, and by reason of a protective tariff this country has not had an old-fashioned period of hard times during the past three years. Nevertheless, there has been a stupendous fall in prices and shrinkage in values of railroad and industrial securities with a severe decline in iron.

"The year 1905 will be the beginning year of a new up cycle in pig iron and long continued prosperity in general business, lasting until the next commercial revulsion, which will be due in 1911.

"When our financial and commercial depressions reach their lowest limits, as determined by the cycles in trade, they afford the best opportunities to make profitable investments of money in property, in railroad stocks, in industrial securities, in manufactures and in mercantile pursuits.

"Looking forward beyond the year 1904 the cycles indicate six years of national prosperity.

"The coming opportunity to catch business and prices at their lowest limits of depression will not happen again for twenty years.

"The prospects of a bright business future were never better for moderate and continued prosperity, but no great boom in prices similar to earlier times when we had $50 pig iron."

Good Law=Common Sense.

In the strike of the building trades in New York City, a striker was arrested who had beaten a workman because he would not leave the wagon he was driving for a lumber company. The striker was arrested and brought before Magistrate Crane, who held him in $500 bail for trial. In doing this, Mr. Crane told the prisoner some home truths. "I want you and every other man to understand," said he, "that it is the right of every one to work or not, as he or she sees fit, and to accept such wages and work such hours and for such employers as they like. In that right they are entitled to protection, which I will give them every time. If this man's work suits him, it is none of your or anybody's business to interfere." This is not only sound common sense, but it is good law. As soon as courts do their duty, and treat lawless labor union men in exactly the same way as other law-breakers are treated, the use of violence in connection with strikes will become a thing of the past.

The Value of the Fingers.

In the early fall all over the world during the beginning of the winter musical and theatrical season a peculiar and large line of business is carried on in a certain channel of life insurance, of which the general public have little or no knowledge whatever. By some underwriters it is termed "freak insurance," and interests principally famous and notable celebrities in the musical and theatrical fields, although this special line of insurance has included costly trained animals used for show purposes.

No less a personage than the celebrated Mme. Patti was one of the originators of this extraordinary kind of insurance. Her gifted voice, which has been heard all over the world, and which is the most intangible of subjects, is insured for $5,000, on which she pays a premium of $125 a performance.

Paderewski, of international reputation, has his hands underwritten for $50,000, and for each of his concerts, a temporary policy is taken out for $7,500. He considers his hands more precious and valuable to him than any other member of his body, for in the loss of them he would be deprived of the means of revealing his soulful music and making his livelihood.

Josef Hofmann, not less famous on both continents, advocates most strongly this kind of insurance, as he goes further into the financial end of it, as can be readily seen, when it is known that he has set a price of $500 on each finger of both hands.

Think of it. Placing the sum of $50,000 on the fingers of your hands! As a matter of fact, Hofmann has placed more insurance on his fingers than on his life. And the same statement holds good for the vast majority of those who insure at a large figure some particular portion of their anatomy.

As a precaution against accident in preventing him to open his performance, Kubelik, the famous musician, has had his right hand insured for $10,000 for each concert, and for $50,000 against total disablement.

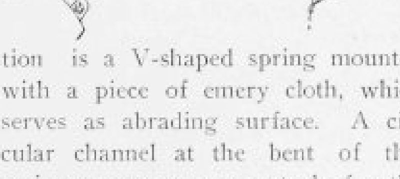
What could a draftsman do if he lost his fingers?

He is fortunate enough to know more than mere drafting and could no doubt turn his attention to several things for support.

There are some in the profession who are doing more for the welfare of men and the nations than all the musicians, and these men should be protected.

Pencil Pointer.

The K. & Co.'s "Duplex" Pencil Pointer, as shown in the above illustration, represents a great improvement over the ordinary sandpaper pad, while its extremely low price speaks for itself. It consists of a nicely finished and nickel plated semi-oval tin tube, which serves as a handle. Sliding in this and held by fric-



tion is a V-shaped spring mounted with a piece of emery cloth, which serves as abrading surface. A circular channel at the bent of this spring serves as a receptacle for the lead filings, whence they can be easily shaken out without soiling the hands.

To sharpen a pencil press the point slightly into the groove formed by the spring and draw it lengthwise from end to end, holding it steady when a flat point is required, and rotating it for a round point. The spring will adjust itself automatically to the proper contact and, owing to the curved abrading surface, a perfect point is obtained.

The emery cloth will last for months. If worn out it can be easily renewed by removing the spring, in which a new sheet is inserted, whereupon it is replaced in the handle.

The K & Co.'s "Duplex" Pencil Pointer, on account of its perfection, simplicity, durability and moderate price, recommends itself to every draftsman, engineer, etc.

Kolesch & Co., New York.

Book Notices.

Architectural Drawing Plates. Folio One. Price, 75 Cents. Details of Construction. Published by The Taylor-Holden Co., Springfield, Mass.

A series of 10 plates, 8x11 inches, arranged for classes in Architectural Drawing, by Frank E. Mathewson, author "Notes for Mechanical Drawing." A limited edition will be ready November 1, 1904. Applications for Folio One filled in order in which they are received. Folios Two and Three in preparation.

"Gasoline Vehicle Management," excellent for its completeness and "useful hints;" another on gasoline cycles that covers the general principles involved in this type of motor.

An exceedingly full index at the close of the book puts its contents into "ready reference" shape, an advantage of no small importance in view of contingencies sometimes happening in the use of the 'mobile.

"The Steel Square Pocket Book," by Dwight L. Stoddard. Published by The Industrial Publication Co., 16 Thomas St., New York City. Price, 50 Cents.

This little book is intended to give short, concise rules and examples of the use of the carpenter's steel square. The aim of the author is to tell all that can be done with the square in the laying out of framing of all kinds, including circular, octagon and square roofs, bicycle tracks, kerfing boards for circle, pipes through roofs, and many other hard problems.

There are 100 pages, with more than an illustration to the page, all on good paper and with clear type, bound in cloth, board backs.

They Ought To.

"How's you gettin' on wid youah 'rithmetic, Lou?"

"I done learned to add up de oughts, but de figgers bodder me."—Collier's.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study.

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Specifications for Marine Engines.

By Carl H. Clark.

The following specifications are intended to serve as a guide in getting out specifications, by bringing to notice the important items and serving as a general outline.

While the specifications as below refer to the triple expansion engine, they may, by suitable changes, apply to any other type.

Engine to be of the three-cylinder, vertical, direct acting type, with cylinders as follows:

H. P. ——— inches diameter.
I. P. ——— inches diameter.
L. P. ——— inches diameter.
with a common stroke of —— inches, designed for a working steam pressure of —— lbs. per sq. in., and to develop about —— I. H. P. at —— turns per minute.

CYLINDERS.—To be arranged in the order of H. P., I. P., L. P., with the L. P. cylinder aft, with receivers between. Cylinders to be of hard, close grained iron, as hard as allowable for proper machining. All ports and passages to be of ample size to allow a free passage of steam. Cylinders to be counterbored top and bottom to allow overtravel of steam rings.

H. P. Cylinder to be —— inches in diameter. Walls to be —— inch thick, and fitted with a hard iron liner —— inch thick, securely fastened in place. To be fitted with a piston valve —— inches in diameter. Valve liners to be —— inch thick, of hard iron. To have a passage leading around cylinder, from H. P. to L. P. steam chests.

I. P. Cylinder. To be —— inches in diameter, walls to be —— inches thick. To be fitted either with a piston valve —— inches in diameter and valve liners —— inches thick, or with a double ported slide valve with separate hard iron valve seat —— inch thick, held in place by composition tap bolts. Slide valve to be fitted with a balance piston.

To have a passage leading around the cylinder from I. P. to L. P. steam chests.

L. P. Cylinder. To be —— inches in diameter. Walls to be —— inches thick. To be fitted with double ported slide valve. Valve seat to be separate, of hard cast iron —— inches thick, fastened in place with composition tap bolts. Slide valve to be fitted with balance piston.

Cylinder bottoms to be....inch thick, and strongly ribbed. Cylinders to have suitable flanges for bolting together, and for securing to columns Drain cocks to be fitted to the bottoms of cylinders and valve chests, piped to condenser and bilge and arranged to be operated from the working platform. Relief valves to be fitted to cylinders and valve chests. All stuffing boxes for piston rods and valve stems to be fitted with approved metallic packing. Indicator cocks and piping to be fitted to each cylinder. Cylinders and valve chests to be covered with non-conducting material and lagged with Russia iron, or polished hard wood. A passover valve to be fitted between H. P. and I. P. steam chests with handle leading to working platform.

CYLINDER HEADS—To be of cast iron......inch thick, well ribbed and covered with polished plates. To be well bolted to cylinders and fitted with lifting eyes and starting screws.

PISTONS—To be of cast iron, hollow box type...... inches deep, well webbed, or of cast steel, conical type of sufficient depth to give good strength. To be fitted with...... suitable rings......inch thick and ......inches wide. Follower to be secured with steel bolts and brass nuts.

PISTON RODS—To be of mild steel......inches diameter in body of rod, to have shoulder under piston, and taper fit to both piston and rod. To have a nut on each end, held in place by approved locking device.

CROSSHEADS—To be of forged or cast steel of either the slipper type or box type and to have a go-ahead bearing surface......inches long and ......inches wide, surfaces to have removable shoes lined with lining metal held in place by dovetailing To be fitted with double wrist-pins each......long and......inches diameter.

GUIDES—To be suited to crosshead, to be securely bolted to back columns and arranged for water circulation.

CONNECTING RODS—Of forged steel......inches in diameter at neck and......inches diameter at lower end. Upper end forked with double wrist-pin bearings each...... inches long and......inches diameter, with composition boxes. Rods to be......inches between centers. Lower end to have tee end to fit box. Crank-pin box to be of bronze lined with white metal, bearing to be......inches long and...... inches diameter. Bolts in upper end to be......inches diameter, and those in lower end to be......inches diameter; nuts to have approved device to prevent loosening.

VALVES AND VALVE GEAR—*Valves* to be of hard cast iron. H. P. piston valve to be......inches in diameter, taking steam at...... I. P. piston valve......inches in diameter, taking steam at....... Steam rings to be of cast iron and removable. Slide valves to be of double ported type, accurately fitted to valve seats. Travel of valves to be......inches. Valves to be secured to stem by composition nuts and washers.

VALVE STEMS—To be forged steel......inches in diameter. To be efficiently guided by composition slides with large bearing surfaces.

LINK MOTION—Of the double bar Stephenson link type, operated both by steam and hand gear and fitted with gag to vary the cut-off.

LINK BLOCK—Of forged steel, with composition sliding shoes.

ECCENTRICS—Of cast iron...... inches face and......inches diameter in halves, set-screwed and keyed to shaft.

ECCENTRIC STRAPS—Of cast iron, lined with white metal and fitted to take the stub ends of rods.

ECCENTRIC RODS—Of forged steel......inches diameter. Upper ends forked for bearings, for connection to link block. Lower end to have tee connection to eccentric straps.

BED PLATE—To be of cast iron, box or girder shape, and strongly webbed. To be at least......inches deep under main bearings and to have all necessary flanges for holding-down bolts, columns, etc. Journal boxes to be of composition, two for each cylinder. Bearings to be...... inches in diameter and......inches long, lined with best anti-friction metal, held in place by dove-tails. Main bearing bolts to be......inches in diameter, nut to be provided with device to prevent unscrewing. Bed to be in......pieces, held together by ......inch fitted bolts.

(If condenser is built into back frame, bed plate to have suitable flanges for bolting to condenser.)

FRAMING—Front columns to be of wrought iron....to each cylinder, turned and finished......inches in diameter, with flanges at each end for bolting to cylinders and bed. Back columns to be of cast iron, box section, one to each cylinder, to have suitable flanges for bolting to bed plate and cylinders, and fitted with lugs to support the main guides. (If condenser is built in, back columns are to rest on condenser.)

CRANKSHAFT—To be of the built up type, of the very best mild steel, in three sections, all interchangeable. Shaft to be......inches in diameter. Crank pins to be...... inches diameter and......inches long. Slabs to be......inches wide and ......inches thick, securely shrunk and keyed together. Coupling flanges to be forged on, and to be......inches diameter and.....inches thick. Couplings to have......bolts in eacn, ...inches in diameter.

SHAFTING—

Thrust Shaft—To be......inches diameter of very best forged steel with......collars. Collars to be..... inches in diameter, ...inches thick, with......inch space between collars. To be fitted with forged couplings ......inches in diameter and.....inches thick, fitted with..... bolts......inches diameter.

Turned Shafting—To be best steel ......inches in diameter, rough turned, except at steady bearings. Couplings to be forged on, to be..... inches diameter and.....inches thick, fitted with......bolts......inches diameter. Steady bearings to be arranged every......feet.

Tail Shaft—To be of best steel ......inches in diameter, with forged coupling at inner end to correspond with the line shafting. Outer end to have taper and key to fit propeller, with nut and keeper outside. To have composition sleeve shrunk on at stuffing box and at stern bearing and between them to be covered with a continuous brass tube made watertight.

THRUST BEARING—To be of the box type with......adjustable horseshoe collars, lined with white metal and properly channeled. Side rods to be of steel......inches in diameter and provided with nuts for adjusting the horseshoes. A steady bearing is to be provided at each end, and the collars to run in oil.

STEADY BEARINGS—To be fitted wherever necessary; of cast iron, lined with white metal.

REVERSING GEAR—To consist of steam cylinder......inches diameter and......inches stroke fitted to one of the back columns. Valve to be controlled by floating lever from working platform. Rock shaft to be ......inches diameter carried in bearings on back columns.

TURNING GEAR—To consist of a cast iron worm and wheel, driven by an engine......inch diameter of cylinder and......inches stroke (or by a ratchet and lever). Worm is to be so arranged as to be easily thrown in and out of gear.

STERN TUBE—To be of cast iron....thick in the body; inner end to have large flange securely bolted to after bulkhead, outer end to be secured to stern post by proper nut on the outside. Tube to be sufficiently supported by framing. Outer bearing to be......inches long and to consist of a composition bush filled with end wood lignum vitæ; inner bearing to be lined with lignum vitæ and fitted with strapping box at inner end.

PROPELLER — Diameter...... feet. Pitch......feet. Expanded area......square feet, to be of sectional type with......blades. Each blade to be bolted to hub with......bolts......inch diameter. Blades to be of......and hub of cast iron. Hub to be bored and carefully fitted to taper of tail shaft. Nut on end of shaft to be covered by a fair water cap bolted on.

PIPING—All steam piping to be of copper, of proper gauges, with brazed flanges, properly bolted together, and must conform to the U. S. Inspection laws. Water piping of brass and galvanized iron. Valves smaller than 2½ inches to be all brass, those above 2½ inches to have cast iron bodies and brass seats and stems. Plugs and cocks to be arranged to drain all parts of the piping system. All steam piping to be covered with approved magnesia covering. Main stop-valve to be a balanced valve with an opening not less than......inches in diameter. Body of cast iron, and valve, seat and stem of composition. To be worked from working platform.

Bilge piping to be of lead, leading to suitable manifolds in engine room and strainers in bilge. All places where moisture can collect to be properly drained.

CONDENSER—To be a surface condenser having......sq. ft. of cooling surface. Shell to be of cast iron or wrought iron, well provided with hand holes. Tubes to be......inches outside diameter of brass. Tube plates to be......inches thick fitted with screw glands, ... supporting plates......inch thick, also to be fitted between tube plates. Shell to be provided with suitable flanges for exhaust and air pump suction. Also soda-cock and salt water feed.

Heads to be of cast iron, bolted to flanges of shell, and to be provided with nozzles, for bolting on circulating pipes.

(If condenser is made a part of the back framing, it must be well ribbed and be provided with proper flanges for bolting to bed plate and back columns.)

LUBRICATION—All bearings to be properly lubricated. Main journals to be fitted with composition oil boxes with a tube for wick feed. Slides, crossheads and crank-pins to have suitable sight feed oil cups fastened to cylinder casings, with leads of copper tube to each journal. Eccentric straps to have oil boxes fastened on the side of the eccentric rods with copper tube leading to the bearing surface. Link gear to be fitted with oil cups.

WATER SERVICE—A complete water service to be fitted to all main bearings, guides, thrust bearings and spring bearings.

LIFTING GEAR—To be fitted for lifting cylinder heads, condenser doors, thrust blocks, and all heavy parts of the machinery.

HANDLING GEAR — At the working platform there will be the following hand gear:

Reversing lever.
Throttle valve lever.
Drain cock lever.
Pass-over valve.

PLATFORMS, LADDERS, ETC.—Engine room floor to be composed of iron plates, well fitted; upper grating to be arranged near the tops of the cylinders, and middle grating at a suitable height for handling the crossheads, stuffing boxes, etc. Ladders to be arranged wherever necessary to reach the various platforms and parts of machinery.

SEA VALVES—To be of suitable design and to consist of the following:

Main injection.
Outboard discharge.
Blow-off.
Bilge discharge.
Air pump discharge.

INDICATOR GEAR — Complete indicator gear with reducing motion to be fitted to each cylinder.

STEAM GAUGES AND FITTINGS—Gauges, etc., to be furnished and fitted in place near working platform; main steam gauge, one gauge for each receiver, vacuum gauge, counter and clock, all of brass, having......inch faces, and neatly mounted on polished hard wood board.

WRENCHES—A full set of working wrenches of polished steel, to be furnished for all parts of the engine, with a rack for same located in engine room.

PUMPS—Circulating pump to be of centrifugal type, driven by an independent engine, with cylinder...... inches diameter and......inches stroke. Pump wheel to be...... inches in diameter of composition; shaft to be brass covered. Suction and discharge pipes to be of copper ......inches diameter.

AIR PUMP—To be independent direct acting:

Air cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

FEED PUMP—To be of duplex type:

Water cylinder......inches diameter.

Steam cylinders......inches diameter.

Stroke......inches.

DONKEY PUMP—To be of duplex type:

Water cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

BILGE PUMP—To be of Duplex type:

Water cylinder......inches diameter.

Steam cylinder......inches diameter.

Stroke......inches.

WATER SERVICE PUMP—To be of Duplex type:

Water cylinders......inches diameter.

Steam cylinders......inches diameter.

Stroke......inches.

INJECTOR—Of ample size to be fitted.

SPARE PARTS—The following spare parts to be furnished:

1 main piston rod.

1 set steam rings for each piston.

12 follower bolts.

1 crank-pin brass complete.

1 crosshead brass complete.

1 main bearing brass complete.

2 crank-pin bolts.

2 cross-head bolts.

2 main bearing bolts.

1 set coupling bolts and nuts complete.

1 crank-shaft.

1 eccentric strap.

1 main valve stem.

1 piston rod for each pump.

1 complete set of valves for each pump.

25 condenser tubes.

1 spring for each relief valve.

1 spare propeller.

1 spare tail shaft.

1 set piston rod packing.

1 set valve stem packing.

All materials used must be best suited to the use to which they are to be put. All castings must be sound and free from blow-holes. All permanently fixed parts must be fastened with fitted bolts, reamed in place. All parts to be readily accessible without disturbing any other part. All workmanship to be of the very best and any portion found defective must be replaced. All necessary wrenches, oil cans and engineers tools to be furnished.

GENERAL.—It is the purpose and intent of these spicifications to furnish an ottfit first class in every Rrespect, and any part not mentioned in these specifications, but necessary to complete the work is to be furnished and fitted without charge.

How Big Clocks Are Made.

The providing of correct time for the world is an important industry. The making of big clocks is one of the features of it. In illustration of this the city of Toronto, Canada, has just completed a clock alongside of which men look like babies. It has a diameter of twenty feet. Its minute hand is twelve feet long, while the hour hand is five feet in length.

The numbers on the face of the clock have a height of two feet and nine inches, and the minute strokes are six inches in length. In performing its daily task of indicating the time, the long hand of this clock travels a quarter of a mile, or ninety-one and a quarter miles a year.

The first thought in the making of a big clock is the weather conditions under which it will have to perform the duty required of it. The hands of the Toronto clock do their work at an elevation of 250 feet, and whether it rains or snows, complete their daily round without resting. But without hands especially built to resist it, a Canadian snow storm would do surprising things, even to twisting and breaking them off.

Where clocks have to work under such weather conditions as the Toronto timepiece does, the hands are made elliptical, in the shape of double sheets of copper, convexed toward the center and strongly riveted every four inches of their length. After the dial was planned, the templet from which the mold was made had to be cut, and the great dial was cast wholly in iron.

The huge frame which contains the intricate and delicate mechanism of the works was also cast in one piece. Remembering that the clock is exposed to the changing conditions of the weather and the influences of these conditions on metal, the necessity of dispensing with nuts, screws and bolts becomes apparent.

Big clock dials vary from eighteen to sixty feet in circumference, and the dial room at a maker of tower clocks is an interesting sight. There are dials of iron in various stages of completion everywhere. They are being painted, glazed and gilded. Those intended to serve in illuminated clocks are glazed with opal glass, as this, better than any other, diffuses the light equally over the surface of the dial. The dial of the Toronto clock weighs about four tons, or 8,000 pounds.

No tower clock like that of Toronto is complete without its bells, and the making of these bells requires much judgment and skill. There must, of course, be the proper proportions of tin and copper, the scientific mixing of them in the furnace, and the exact moment must be known to run the metal into the mould, after the cores from which the bells are shaped have been built up and dried.

Then there is the tuning of the bells. To tune a bell is declared to be a most difficult business, because when struck it sounds a trio of notes instead of one. Consequently it requires an expert ear to catch the dominant note. By a special machine invented by the firm which constructed the Toronto clock, this difficulty has been overcome, and the operation of tuning much simplified.

The bell is inverted. It is held stationary by powerful grips, the steel cutters for paring the metal to secure the required notes being in the interior. These cutters are revolved by machinery, and shave the metal as easily as a plane shaves a plank. In this manner the bell is toned either up or down, as desired, till the correct note is secured.

From this it will be seen that the building of a big clock is no light labor. It requires the skill and cunning of scores of hands, and they must see that it gives correct time to the thousands who daily look up to it.

Professor Unwin.

Engineers everywhere know Prof. Unwin, or at least know of him through his writings, and will be interested, therefore, in the announcement made a short time ago that he would retire from active work at the Central Technical College of the City and Guilds of London at the end of the college session. The monthly journal of the college, The Central, has commented on the event as follows:

"It is with the very deepest regret that we have to record the approaching retirement of Prof. Unwin at the end of the present session. The college will thereby lose a professor of whose eminence and ability it would be presumptuous for us to speak, and whose teaching and personal influence will always be gratefully remembered by those who have been privileged to work as his students. Making, as it does, the first break in the original professorate of the college, a professorate which has raised it in a period of a little less than twenty years from small beginnings to its present position, the change is an important event in the history of the Central. * * * Prof. Unwin was appointed to the professorship of civil and mechanical engineering by the institute at the opening of the college early in 1884, and served as Dean from that date until midsummer, 1895, and again during the last two sessions. In 1901, when the reconstituted University of London added a faculty of engineering, Prof. Unwin was made university professor in that subject."

ELECTRICAL.

Lava for Mechanical and Electrical Purposes.

The material now so well known as "Lava" through its universal use in the manufacture of gas tips and burners, and its widespread applications in the electrical arts, is not, as is frequently supposed, a natural product of volcanic origin. It is the mineral Talc (H2, MG3, SI4, O12), which is machined in its natural condition and then baked under certain conditions of time and temperature (about 2000 degrees Fahrenheit or 1100 degrees Centigrade) to a condition of such extreme hardness that when properly kilned it can scarcely be cut except by diamond.

The material, being baked as stated at a temperature of about 2000 degrees, is unaffected by any subsequent temperature short of that heat, and therefore by any heat to which it may be exposed when used in the construction of arc lamps, rheostats, electric heating apparatus, etc., etc.—in fact, under any conceivable circumstances a lava insulator would withstand a far greater heat than the conductor which it protected.

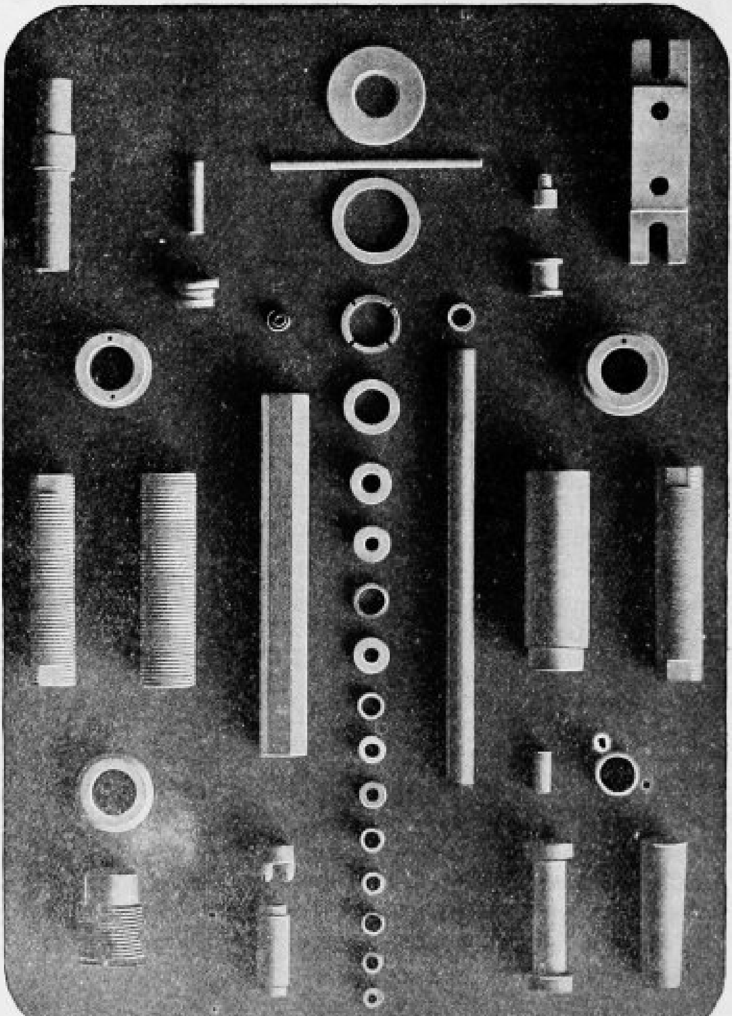
It fuses with difficulty under a strong blast flame and has no superior in withstanding the electric arc. It is only slowly dissolved by hydrochloric acid and is not affected at all by other acids or by alkali. It is absolutely free from metal oxides or other impurities which would impair its insulating value. It is permanent in constitution and, being a natural product, is not subject to variations in structure or composition. It neither swells nor shrinks with changes in atmospheric moisture, and its co-efficient of expansion with temperature being negligibly small, *it is of especial value in instruments requiring a fixed relation of their parts under all conditions.*

The material before baking is sawn, milled, drilled, turned and threaded with the same freedom as metals, such as brass, and by tools of the same character. Lava products are produced with the same degree of accuracy and interchangeability as those of a screw machine and without the necessity of first making dies or molds.

For most work and for pieces of bulk the method of baking is much the same as with porcelain, where coal and coke ovens are used, while with pieces of moderate size, and especially where close control of temperature is desired for the purpose of extreme accuracy and uniformity, the electric furnace or gas blast furnaces are employed.

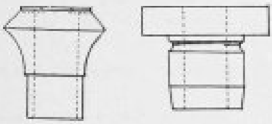
With respect to accuracy, from the

method of working highly satisfactory results are clearly obtainable. Arc lamp carbon-guide bushings (as shown above), are made in thousands product, lava offers unusual advantages in respect to uniformity and is much superior to porcelain in this regard.



according to limit gauges allowing from but one and one-half to less than one-half of one per cent. total variation in dimensions. For a kilned

Many tests for dielectric strength made with transformers of large capacity and carefully calibrated electrostatic voltmeters have demonstrated that lave is remarkably uniform in its ability to withstand high potentials, not only momentarily, but when continued indefinitely, as its "dielectric hysteresis" and surface creepage loss cause no more heating under continued stress than in the case of porcelain under the same conditions. Its dielectric strength may be expressed as from 75 to 250 volts per thousandth of an inch thickness, depending, as in the case of all other electrical insulators, upon the absolute thickness of the sample tested.



From the foregoing it is evident that there are many opportunities for the use of lava outside of electric insulation. It being acid proof and superior to porcelain and glass in heat resisting qualities as well as in strength, and being turned cheaply in moderate quantities without the cost of dies or molds, it is for many purposes the most practicable of the materials possessing any of the above qualities, while no other material now in use combines them all. As compared with wood, horn, fibre and compositions of rubber, etc., etc., it is frequently cheaper and always better. As compared with mica, lava lends itself to a large variety of shapes in which mica cannot be employed.

Cost being an important consideration, it is worth while to call attention to the fact that improvements and economies in lava working have kept pace with the times with the result that the price of lava has now reached a point where it competes with most of the commoner insulating materials. Particular emphasis is laid on this point for the reason that lavas, which were superseded five or six years ago by other materials in an effort to cheapen production, are now procurable at one-half and in many cases at one-fourth the former costs.

Everything being made up according to the requirements and designs of apparatus manufacturers, there are no standard forms which can be catalogued or priced, but the cut will illustrate a very few of the uses to which some of the electrical manufacturers are putting lava. These illustrations suggest opportunities for the employment of this material, and are samples of the production of the American Lava Company, Chattanooga, Tennessee.

Conventional Signs Used by Foreign Electrical Draftsmen.

Blueprints and drawings laid out by German, Austrian and Italian engineers and draftsmen in their designs for wiring of buildings, etc., are generally most elaborate. Every little detail is shown in a most painstaking manner, and the signs here illustrated are universally used in the countries mentioned, to designate the material or apparatus to be used for proposed plants, says Arthur D'Romitra, in the Western Electrician.

One readily gets accustomed to them, and I find that in estimating for foreign work, the use of foreign prints with these symbols greatly accelerates the capabilities of the estimate department. The following conventional symbols are used in the three above named countries:

Conductors: B., bare copper; B. E., bare iron galvanized; G., seamless

Ordinary return circuit.

Three-wire or alternating-current circuit.

Flexible conduit, armored (Greenfield type).

Vertical mains, up and down.

Switchboard, two-wire system.

Switchboard, three-wire system, or alternating.

Rheostat or heating appliance of ten amperes.

Portable rheostat of six amperes.

Choking coil.

Lightning arrester.

Lightning-rod tip.

Ground.

Accumulators or secondary batteries.

Dynamo or generator, with ten kilowatts capacity.

Motor with two kilowatts capacity.

Transformer with capacity of eighty-five kilowatts.

Two-wire meter, with capacity of five kilowatts.

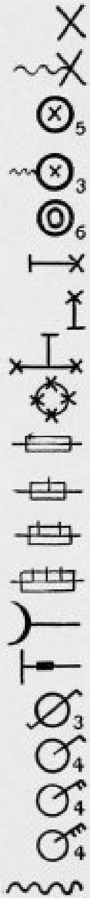
Three-wire or alternating-current meter with capacity of ten kilowatts.

Ammeter.

Voltmeter.

rubber insulation; L., flexible cords; K. B., bare lead-covered cable; K. A., lead-covered cable with asphaltum-taped cover; K. E., lead-covered cable, armored; g., conductors on insulators; mored; g., conductors on insulators; o., conductors in iron conduit.

Firms making out plans and drawings to be used in the before-mentioned countries will do well to consider these symbols and also carefully to add in figures the proposed amperes to be carried on each wire or cable.—*Popular Mechanics.*



Fixed incandescent lamp.

Portable incandescent lamp.

Stationary group of incandescent lamps; number of lamps, five.

Portable group of incandescent lamps; number of lamps, three.

Arc lamps of six amperes.

Wall bracket (one lamp).

Standing lamp (one lamp).

Hanging lamps (two lamps).

Electroller (four lamps).

Wall tube.

Single-pole cut-out; if a figure is alongside, it denotes amperes.

Double-pole cut-out; if a figure is alongside, it denotes amperes.

Three-pole cut-out; if a figure is alongside, it denotes amperes.

Wall attachment.

Small branch cut-out.

Reversing or pole-changing switch for three amperes.

Single-pole switch for four amperes.

Double-pole switch for four amperes.

Three-pole switch for four amperes.

Single circuit (flexible cord).

The propellers of the fast auto boats revolve 1,250 times a minute, giving a speed of 25 miles an hour.

Two hundred machines which supply newspapers on coins being placed in the slot are now installed in Berlin.

STRUCTURAL.

Wind Bracing in Steel Frame Buildings,

A Theory with Special Reference to Knee Brace Design

BY R. B. WOOWORTH ENGINEERING DEPARTMENT CARNEGIE STEEL CO.

Stability of buildings subject to external forces is a problem to be investigated and solved in accordance with the fundamental laws of mechanics and the strength of materials as determined from the theory of flexure. Any solution of the problem which does not agree with what has been demonstrated as to the behavior of materials under stress must necessarily be imperfect, if not erroneous.

Now, a building may fail in one of three ways, in the direction either of its length or its width. It may collapse vertically by reason of the weakness of the materials of which it is composed and upon which the loads it was designed to bear are superimposed. It may give way in a horizontal direction under the influence of shearing forces, either by lateral displacement from its foundations, or by buckling of its various members on account of their weakness to resist these forces. Or, if the framework is strong enough to carry safely the vertical reactions due to the loads it may have been intended to bear and stiff enough to resist the shearing stresses produced by external horizontal forces, it may yet fail by being overturned bodily through its own weakness to resist the upward reactions produced by these horizontal forces.

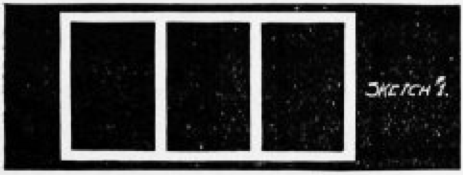
The ordinary vertical reactions in a building caused by the loads imposed upon its frame are readily determined and provided for in its design. The external forces which cause horizontal shears that must necessarily be transformed into vertical stresses before they reach the foundations are not so easily taken care of in its design. It is believed, however, that these also can be made amenable to satisfactory treatment and safely provided for. The only external forces acting in a horizontal direction upon a building, with rare exception, are those produced by wind and storms, and these alone produce dangerous effects, tending to overturn the building upon its base.

Now, a masonry pier is a structure subject to horizontal forces similar to those in a building caused by the pressure exerted by the wind, by the action of ice in motion, by collision with boats, or other means. It acts as a homogeneous whole, the blocks of which it is composed resisting all compressive stresses, while the tensile stresses are taken up by the cement, drift bolts, or other means used to bind its parts firmly together into one solid mass. The moment of its resistance to all forces tending to overturn and thus destroy it, is, of course, the product of its mass into half its width in the line of resultant stress. As on the already mentioned supposition that the pier is a homogeneous whole, its neutral axis passes through its center and is distant from either side of the pier by half its width in either direction, this moment of resistance is equal to the weight of the pier multiplied by the distance from its neutral axis to the outside fiber.

A building differs from a solid masonry pier chiefly in that it is not a homogeneous whole; the vertical loads carried to its base are not uniformly distributed over the entire area of the same, nor are the members of its frame so united as to act vertically, horizontally, or diagonally with the readiness displayed in the several parts of the pier—stones, cement, dowels, clamps, drift bolts, etc. And yet, when we come to consider its moment of resistance to overturning at its base, this moment can only be measured in terms of the several moments of the separate weights resting upon that base by their several and separate distances from the neutral axis. The point of application of these weights can be gotten directly from the footing plan of the building, and the position of the neutral axis, and with it the moment of resistance, determined by the usual formulas.

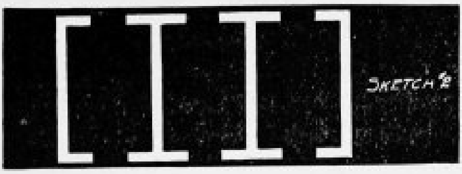
This neutral axis will not be coincident with the center line of the building, unless the loads are symmetrically applied on the footings. In a steel frame building this is but seldom or never the case; a heavy spandrel wall on one side and a curtain wall on the other, unequal loading due to elevator framing, stairways, vaults, and what not else—these are some of the things which make it necessary to determine the position of the neutral axis by independent calculations at each and every section made by a row of columns normal to the general direction of the axis. But when once this neutral axis is found, and the moments of these separate weights are determined, it will be at once apparent that to insure the stability of the structure it will only be necessary to proportion the several parts of the building in accordance with the laws of flexure. For, of course, the value of the building as a whole, considered as a medium of resistance to the wind, will be the value of its moment of resistance. If, now, the building is strong enough to resist all vertical reactions, and stiff enough to resist buckling under horizontal stresses, and so heavy that its moment of resistance, as thus determined, will exceed the uplift on the windward side due to the overturning moment produced by the wind, there can be no question but that the structure as a whole has been correctly designed to perform all its work.

The horizontal forces by which the pressure of the wind on the sides of a building are represented must be resisted by the internal strains in the various parts of the building, and the work to be done by the wind in overturning or buckling the building must, in view to safety, be equaled by the work done by the parts of the struc-into vertical, diagonal and horizontal reactions, transforming them into vertical, diagonal and hirizontal stresses, and transferring them to the foundations. In this way the sides of the building must act like the chords of a truss, or the flanges of a beam, and the partitions or end walls like the web members. Now, in a building constructed with solid end walls and partitions represented in sketch No. 1, it is apparent that the building will be safe as against wind pressure only in so far as the transverse walls are strong enough to resist tension and compression caused by the transformation diagonally of horizontal shears into vertical reactions and the side walls are strong enough to resist the crushing or pulling apart, caused by their action as chords. The materials of the interior walls, therefore, would have to be investigated as to their ability to resist shearing intensity, and the outside walls to resist compression, while the cement or other bonding material would have to be designed to resist pulling apart. If, now, the wind forces are considered as concentrated at the outside walls, and at the partitions and sections made at these points it will be readily apparent what is the true character of the building as subject to mathematical investigation.

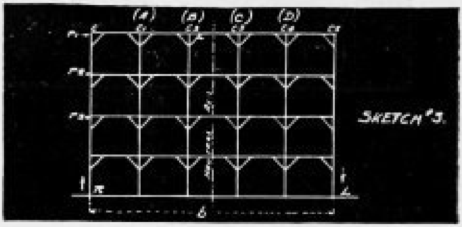


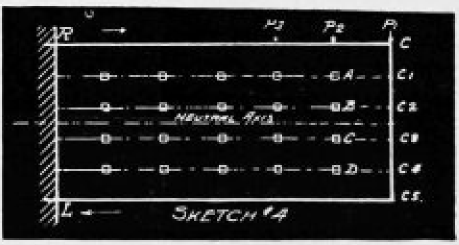
As shown by sketch No. 2, we have a series of beams and channels on end, and what is true of beams in general must be true of these stone or brick beams in particular. They must be figured as cantilever beams fixed at the foundations and loaded uniformly with the wind pressure, and the materials in them must be calculated in accordance with the usual formulas for the flexure of beams in general.

In a steel building of the skeleton type, we have no solid webs, as in the case supposed. The floors are usually open from wall to wall; the partitions are too thin to resist shearing stresses of any great intensity, and their location is never definitely and finally known to the designer, except in special portions of the building, inasmuch as they are liable to removal at the will of the tenants. The end walls, likewise, are cut up by openings for doors and windows, and there could, in no case, exist any true bond between the materials of the wall and the steel spandrel beams or girders. Consequently, the designer cannot rely, in any measure, upon them for aid in resisting the wind forces. The stiffness of the floors, the resistance of the partitions, and the general rigidity of the building, due to careful attention to



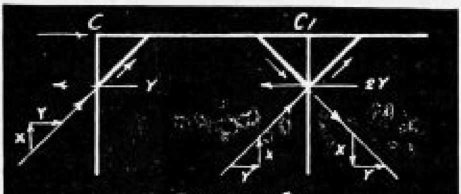
connections, may avail much or little. It is the duty of the designer intrusted with the responsibility for the interests of the owners, and the security and perhaps the lives of the tenants, not to rely upon elements of strength, uncertain in value and irreducible to calculation. What shall he do? The answer is easy. He must make provision in his design of the steel frame to resist these horizontal forces. If he can put in diagonal systems of wind bracing at any point, let him do so, and let him design them for the full force of the wind contributory to the area covered by their influence. If he cannot make them sufficient for the total wind force, let him make force, let him make them as strong as the dead load in his columns will allow; but let him beware lest he pull up his columns bodily by the roots. If he cannot get material enough in this way to resist the figured wind pressure by such tower bracing, considering the building as a cantilever truss, with center to center of chords equal to center to cen-





ter of the columns thus braced, he must do what he can further in the line of knee braces, lattice girders or portals. The calculation of a diagonal system is simple; it is believed that the method now to be outlined for bracing with plate or lattice girders and knee braces is in exact accord with the fundamental laws which must govern all calculations involved in the investigation of stability in structures.

Let a transverse section of our steel frame building be represented in sketch No. 3. It is proposed to use girders and knee braces to resist the wind forces and to transfer them into the foundation. If now the building be the same as that already discussed, with the exception that the place of the partition walls is taken by the columns, it is certain that the moment of resistance at the footings must be the same as before, lessened by the difference between the weights of the walls, etc., and the weights carried by the steel frame. The area of the base is the same, the lever arms are the same, and the only difference consists in the weights themselves and their modes of application at the footing line. The moment of resistance of the building, considered as a whole, must be computed in the same way, viz., by reference to the neutral axis. On this principle, the stresses in the outside columns must be computed as for a cantilever beam. The moments of the several wind forces about "R" or "L" will be equal to their several intensities by their distance above these points, and the stress in the outside columns (fibers of our cantilever beam) will be the quotient of their sums (total bending moment about "R" or "L") divided by "b," the depth strength, and vertical shearing stress in our beam. Take the longitudinal stresses a moment. At the top of the beam these are tensile, at the bottom they are compressive, at the neutral axis they do not exist, but at any area between the neutral axis, as at "A" and "B" and the top of the beam, or similarly between the bottom and the neutral axis, they do exist, and their intensity is directly proportional to their distance from the neutral axis. If now these areas "A" and "B" extend from end to end of the beam, the strip of beam represented by them must be subject to longitudinal stress at all points. This stress will vary in intensity parallel to the intensity of the



SKETCH #5.

of the beam. This stress will, of course, be tensile in the windward column, and compressive in the leeward, and equal each to the other, and will have to be added to the other stresses in the latter column caused by the vertical loads. The tensile stress in the windward column must not exceed the steady load (dead and a small live load) on the column, otherwise anchorage must be provided to resist the upward reaction.

Let us lay our building on its side, as shown in sketch No. 4, omitting the interior columns and braces, and consider it as a cantilever beam as before. Now the forces P1, P2 and P3 produce longitudinal compressive and tensile stress in the top flange, and will always be in direct proportion thereto. By reference to sketch No. 3 it will be seen that these areas "A," "B," "C" and "D" lie in the plane of column C1, C2, C3 and C4 It would appear reasonable, therefore, that if we leave out the strip of web plate between the top of the beam and "A," or between "A" and "B," as we propose to do in the use of knee braces, any columns at these planes would be stressed in proportion to their distance from this neutral axis, just exactly as they would be were the web plate entire. That is, if we leave out the solid partition walls depended upon in our primary consideration to transform horizontal shear into vertical stresses and replace them by columns and brackets, these columns and brackets must do the work supposed to be done by the walls. Moreover, were the structure to fail by deflection from the straight line, it must do so as the result of forces causing the tension flange to elongate and the compression flange to shorten as the result of the work done by them in straining the structure. It need not be said that the interior columns must follow suit, and lengthen or shorten accordingly. Any work done, therefore, by the wind to induce such deflection and failure must be resisted by internal strain in these interior columns.

As to shearing effects, in a rolled beam or in a plate girder without stiffeners, the shear is constant from the top of the beam to the bottom, and its intensity per square inch is equal to the shear at any point, divided by the area of the web plate for a strip an inch wide. The portion of the total shear taken by any section of the plate would then be equal to its depth, divided by the depth of the girder. By reference to sketch No. 4 it will be seen that if the portion of the web represented by area "A" be taken to include one-half of the whole strip from the line at "B" to the top of the beam, we can consider the whole shear in that section to be concentrated at "A" and acting as a unit at that point; on which consideration we have to assume that if the web is cut away, as a force at "A" to balance this shear, otherwise our structure will fail. Now, the only stresses in our structure under present consideration are those caused by these shears in their transference from horizontal to vertical reactions. The work of this transfer is done by the brackets. The columns cannot take horizontal stresses for transmission to the foundations until the same have been transferred into vertical reactions. This transformation must be done by the brackets, and the proportion of horizontal shear taken by each bracket from the line of girders will, if our analysis be correct, be determined by the contributory area of our web plate. If our columns were spaced equally, then the outside columns would each receive one-tenth of the total shear, while the interior column would receive twice as much, or one-fifth each, strictly in proportion to the amount of web plate represented by its contributory area at any section. This also seems to result from an analysis of these brackets.

Suppose the brackets to be equally strong, then each bracket will take the same amount of shear from the girder, which now represents the thin strip of web plate and which is supposed to be equally stressed from end to end. Suppose the brackets to be cut at 45 degrees. Suppose the amount of shear taken by the bracket at column "C" to be "y" (horizontal component). The bracket takes this shear by bending the girder vertically, equal to component "x," and the column horizontally equal to component "y." At column C1, as shown by the sketch, the bending in the column amounts to two "y," which is as it should be on the supposition made. The interior columns then on equal spans center to center of columns should be calculated to resist twice the bending taken by the outside columns. The vertical stresses in the columns caused by the knee braces cannot be determined by an analysis of their reactions. For at column C1, by the analysis on sketch there would be no vertical component to go into this column, and of the total shear at this level all that would produce vertical reaction in the columns would be one-fifth of the total, which is supposed to pass into the exterior columns. If the accumulated shear at this level were 1,000 pounds, then, by analysis of the bracket, the outside columns would take 100 pounds each as increment of chord stress, whereas, for ten-foot story and a ten-foot span they should take $\frac{1,000 \times 10}{50} = 200$ pounds. The stresses in these brackets and bending moments in girder and columns must therefore be computed in accordance with the methods given in the standard works on portal and knee bracing in bridge construction. The vertical reactions are obtained in line with the analysis of cantilever beam work, to which allusion has already been made.

"Fireproof Magazine."

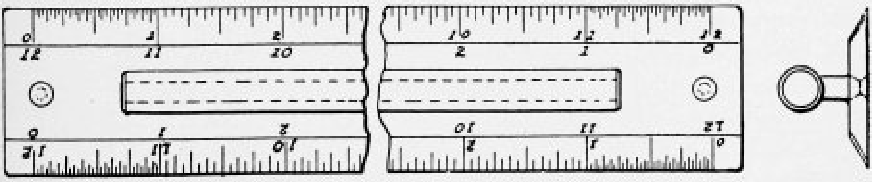
Editor *The Draftsman*:

Having noticed articles in *The Draftsman* of late in regard to simplifying a draftman's work, and thinking the readers might still be interested in another, I enclose a sketch of a special scale I had made to order.

The scale is graduated full size on up as a triangular scale and is always right when laid down.

The small circles at the ends are of soft rubber, which prevents it from sliding off the drawing board, even at a 45° slant.

I also find these little rubbers work equally well in triangles.



both edges, with the end inches 32ds and the intermediate inches in 16ths, numbered from both ways.

With this scale any line can be scaled at once without turning the scale end for end or over, as some of the four graduations will come right.

The handle makes it as easy to pick

I believe every draftsman would find it a great convenience to have as many different scales as their work required, as the first cost is small, when considering time saved using the scale instead of the old-fashioned triangular scale.

E. A. Chamberlin,

In China a mile is anything from a quarter of a mile to a mile and three-quarters, according to the province in which it may happen to be.

Captain Fritz-Egger, a Swiss cavalry officer, has invented a method of horseshoeing by fastening the shoe to the hoot with metallic bands.

HOME STUDY.

COURSE II. Machine Design

Chapter III.

Pipes and pipe fittings enter so often into the work of the machine designer that a chapter has been put in here to show the form of some of the most common connections and the method of calculating pipes for strength.

Pipes used in engine and boiler room equipment are of wrought or cast iron, made in standard sizes from $\frac{1}{4}''$ internal diameter up and from 16′ to 20′ long. For sizes above 16″ diameter, pipes are of cast iron. Connections for all sizes are of cast iron. For the small sizes, pipes are usually threaded and screwed into the fittings. For large sizes, they are made either with flanges cast on, or they are threaded and a flange is screwed on which bolts to a flange on the fitting.

A standard wrought iron pipe table is shown on page 194, Kent's Mechanical Engineers' Pocketbook. (See supplement to *The Draftsman* for July.) In the first column of the table, is given the nominal inside diameter, which is a little less than the actual inside diameter. This is the size that is always used in specifications. The headings to the other columns will explain themselves.

The designer often has occasion to use the columns giving weight and capacity in laying out systems for steam or water. The external area is used in calculating the radiating surface, as for example, in steam heating plants, where pipe coils are used as in Fig. 1.

Standard piping is tested to pressures higher than are ordinarily used in practice so that the draftsman has only to select from the table the size of pipe he wants, but he may have occasion sometimes to figure the thickness of a pipe for himself.

A method for doing this is given and it will be seen that it is similar to that used in Chapter II for calculating a steam cylinder.

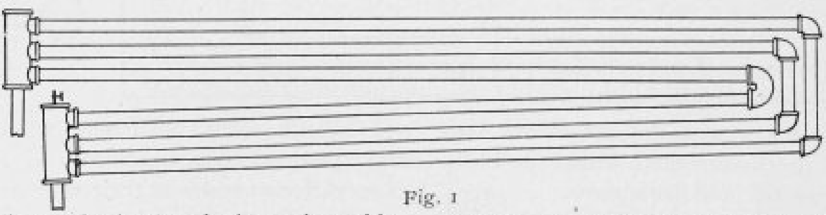


Fig. 1

Let d=internal diameter of pipe in inches.

Let l=length of pipe in inches.

Let t=thickness of pipe in inches.

Let s=tensile strength of material per square inch.

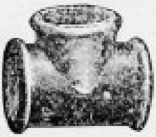
If a section of pipe of any length be taken, it will be seen by referring to Chapter II that the resistance to bursting=2tls and also that the bursting pressure=pld.

Equating these, we have: 2tls=pld.

$$\text{or } t = \frac{pd}{2s}$$

The thicknesses given in the table referred to above correspond to a tensile strength of 4,000 for wrought iron and a factor of safety of about 10. The pipes being tested to 500 lbs. per sq. in.

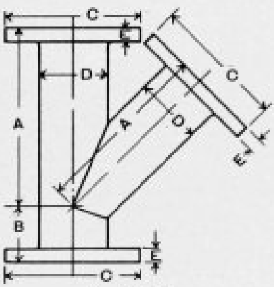
Elbows



Tee.

For cast iron pipes, s should be taken at about 18,000 with a factor of safety of 5 to 6.

The fittings used in steam and water piping are of malleable or cast iron They are named according to their shape, tees, elbows, crosses, etc.

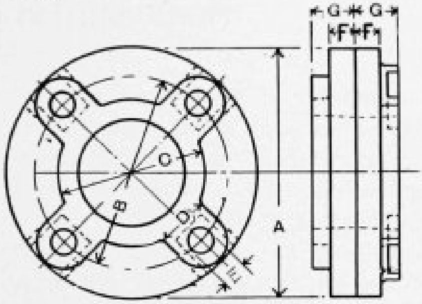


Laterial.

Manufacturers' catalogues, giving standard sizes and shapes, can usually be had for the asking. Crane, Lunkenheimer, Crosby and Walworth are standard and well known, or the book published by *The Draftsman*, giving dimensions of Pipe, Fittings and Valves.

To make this plate, get one of the catalogs above or some other and lay out the several pieces indicated from the dimensions given in the tables of the catalog.

1. A 2″ x 2″ x 1½″ T (screwed fitting.)

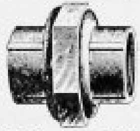


Flange Unions.

2. A 2½″ elbow (flanged fitting.)
3. A 45° 6″ lateral (flanged fitting.)
4. A 2″ flange for low pressure (screwed fitting.)
5. A 1½″ union.
6. A 3″ x 2″ straight reducer (flanged.)

The student will have to pick out a suitable scale for these pieces so as to get them all on the drawing.

Practice in such work is necessary. Get approximately the size of the pieces, then determine the best scale to use, and divide the plate off roughly into spaces for their accommodation. The dimensions of this plate will be



Malleable Unions.

the same as in the previous chapters. (14 x 19 with 13 x 17 border lines with ½″ margins at right, top and bottom and 1½″ at the left.)

CURRENT TOPICS.

The Evolution of a Note Book.

By E. J. Lees.

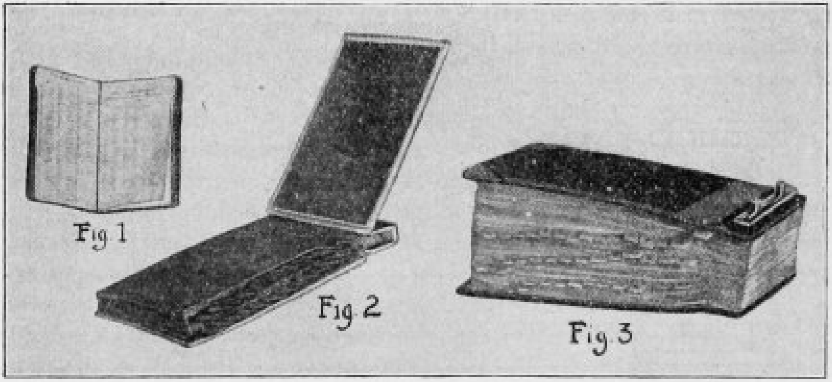
A number of years ago the writer decided to start a note book along mechanical lines, and the small alphabetical indexed one shown in Fig. 1 was purchased.

At first, all items of interest and of use in the drafting room were copied in this book with India ink, the work and time, of course, being considerable, and as each letter was limited to a few pages the natural result was that the space for the most used letters was soon filled.

Then it was a question of another book, or paste in between the filled pages, which soon made the book clumsy and broke its back.

Soon after the book reached this stage the standardization of catalogs, etc., was recommended and the mechanical periodicals took up the idea. One of them especially began publishing data sheets 6 by 9 inches as a supplement. (The Draftsman is using the same size.) As this idea became more generally adopted, catalogs and other printed matter began to appear in this size, and since they often contained much useful information which either required copying or a larger book, arranged to hold these pages.

In looking for something to hold these loose pages, data sheets and blue prints, the spring back binder was adopted and matter that was collected was placed therein, as shown in Fig. 2.



This went fairly well, but as the collection grew an index was necessary, so the adjustable index tags were adopted and placed along the edges.

This made a very good arrangement, but has its drawbacks, as follows:

First.—The springback is limited as to its capacity.

Second.—The index tags are rather thick and give the pages a wedge section, which has a tendency to assume a fan shape, and to offset this brass fasteners were inserted. This held all right, but when a new sheet was to be inserted all sheets had to be removed and replaced in order again.

Third.—Unless one has a good memory it is rather tedious to look over the tags to find the article wanted.

A next move was to secure a sectional post binder (See Fig. 3), and a quantity of plain paper cut to suit this binder (See Fig. 4).

It will be noticed that these pages are notched through the back, thus allowing them to be placed in position without removing the other sheets already in place.

The use of this book is as follows, and, as far as the writer knows, is original.

Data sheets, blue prints, photographs, etc., that are 6x9", or nearly so, are all glued on to the plan 6x9" sheets at the inside edge only, this point is very particular, as when the book becomes large, the curvature when open will break off the glued part or tear it, if glued on either top or bottom edge.

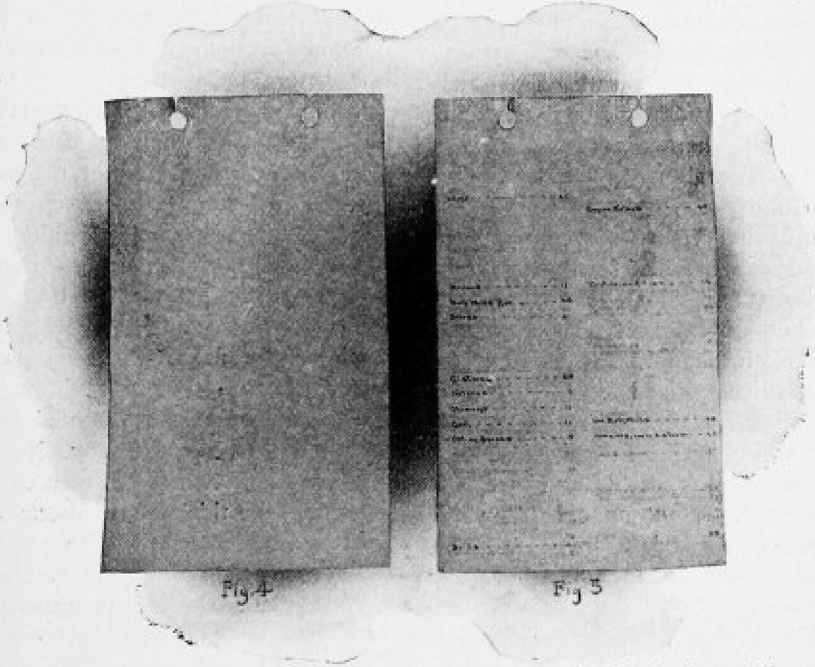


Fig. 4 Fig. 5

Articles published in magazines or any small reading matter scattered around a cut, for instance, are clipped out and arranged on the plain sheets to be inserted, always bearing in mind that the gluing must be done on the edge toward the binders.

Tables from catalogues, etc., that are printed on both sides and sometimes take two pages to a table of dimensions, may be pasted in as follows: Glue on to the plain sheets, taking care to keep the reading in line, as it was in the catalog, and then cut away the blank page in between, leaving only the perforated portion at the post to bind with.

The indexing is alphabetical in connection with numbered subjects. (Fig. 5.)

The plain sheets are used for the alphabetical index and may be typewritten, a large heading for each letter and the subject and subject number in line underneath. The numbers for the subjects may be as many as desired, the number being fastened to the first sheet only in each division, thus allowing expansion or contraction and rearrangement, a sheet being easily pulled out when those above are lifted slightly.

These numbers are printed on tracing cloth about ½" wide, and are doubled and glued on each side of the sheet, making a very substantial tag which projects out far enough to be easily located, and are also staggered, or put on one below the other, in numerical order, the note book shown up to date having 44 numbers.

The method of determining where to place any new sheet is very simple, from the fact that one does not depend entirely on all matter being exactly the same nature under each number.

For example, look up *Bolts*, in the alphabetical index. We find it under No. 19. Suppose we have some data on nuts to file, instead of starting a new number for this, we file it under 19 also, taking care that under the letter *N* we enter *Nuts* No. 19.

In a few days some data on taps is received. Now we can either start a new number under T, or if No. 19 is not too full for easy handling, we can also file this under No. 19.

Should No. 19 eventually become too bulky, start a number, or remove the subject most used, and change the index to suit.

Up to date, however, the writer has not found it necessary to rearrange the matter this way, as a little care in noticing the quantity of material in a section will govern the location before being filed.

The good feature of this system being that only the first page of each section being numbered, it makes it possible to change without erasures, etc., and the alphabetical index, as fast as filled up, can be retypewritten and allowance made each time for additional items, thus making the whole scheme flexible in every direction.

The number tags are started from the binder end at the top, No. 1, down to the bottom edge, then to the top again, the thickness of sheets and insertions making it easy to see the second and third row of numbers.

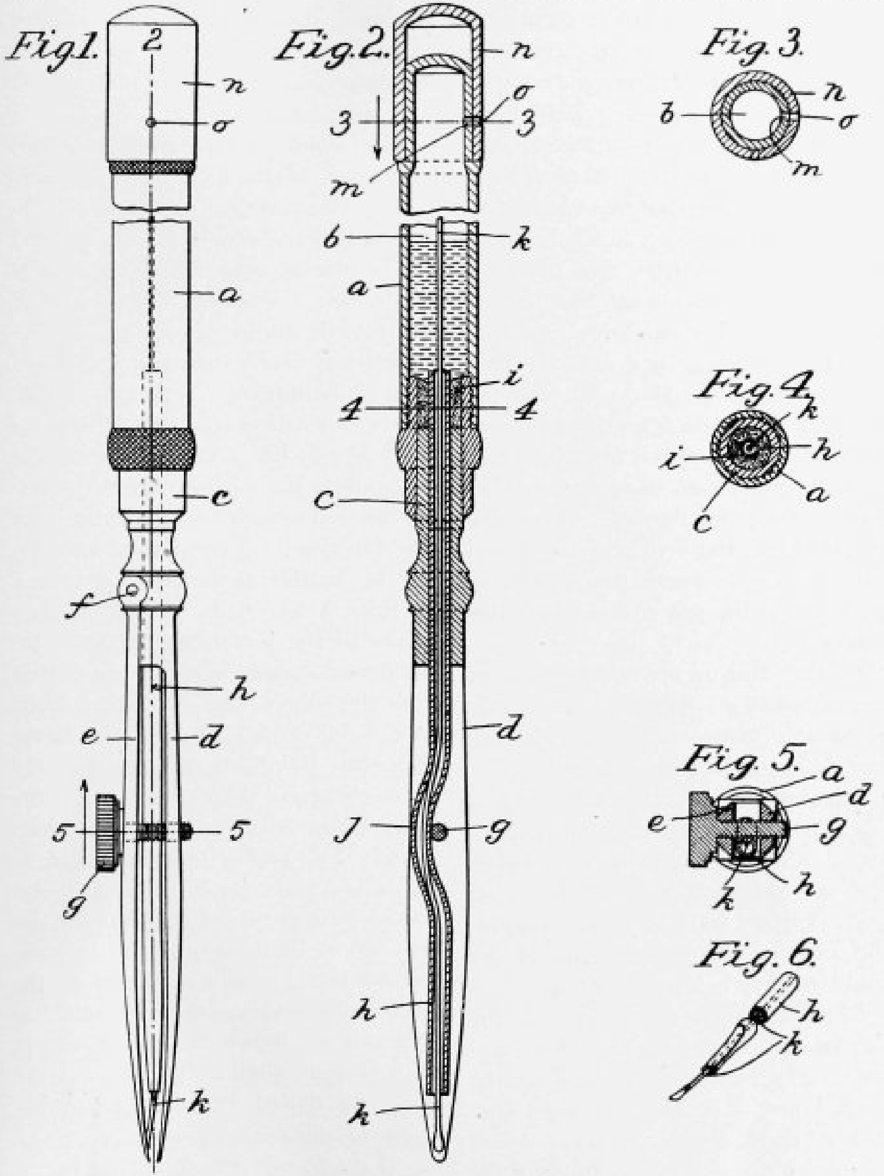
Some data sheets are published with two or more different topics. These can be cut up to locate under different heads or can be filed as they are and index numbered to suit.

The new Springfield rifle is probably the most effective military arm in the world. At a distance of 50 feet it penetrates 55 one-inch pine boards placed one inch part. It has a muzzle velocity of 2,300 feet per second and carries a ball five miles, although one mile is the greatest distance that any rifle can be effective, even with telescopic sights.

Drawing Pen.

The invention relates to the construction of drawing-pens and it has for its object the production of a pen of this type which shall be self-feeding.

The reader is aware that it is not broadly new to provide an ink-reservoir for ruling-pens, but such pens are in almost constant use, and it is not as difficult, therefore, to adapt a feeding



device thereto. With drafting-pens the case is otherwise, for their use is not constant and the inks usually employed therewith are quick-drying, relatively non-limpid, and these facts greatly affect the question of feed and affect it adversely.

This invention consists in constructing an ink-reservoir in the handle of an ordinary drafting-pen and in providing a feed-tube whose eduction end is located near the nibs of the pen, the reservoir being provided with a vent in the upper end thereof, which may be opened to allow ink to fill the space between the end of the feed-tube and the nibs, the vent being then closed to prevent further excessive feed. If, therefore, a pen be laid aside, the ink between the nibs may dry up; but the pen may be opened and cleaned, as with ordinary pens of this type, and another supply of ink permitted to flow to the point thereof. When the pen is in use, the vent may be opened more or less to permit the supply to the point of the pen to be renewed as needed.

In the drawings forming part of this application, Figure 1 is a side elevation of a pen embodying this invention, considerably enlarged. Fig. 2 is a similar view in section. Fig. 3 is a cross-section on line 3 3, Fig. 2. Fig. 4 is a similar section on line 4 4, Fig. 2. Fig. 5 is a cross-section on line 5, Fig. 1; and Fig. 6 is a perspective view of the delivery end of the feed-tube and feed-wire therein.

Referring to the drawings, *a* is the handle of the pen, which is hollowed out to constitute a reservoir *b* for the ink. This handle has one closed end, and its opposite end is threaded and screwed onto the metal shank *c* of the pen, as shown in Fig. 2. To this shank one of the legs, *d*, of the pen is rigidly secured, the other leg, *e*, being hinged to the shank at *f*. An adjusting-screw *g* for these legs is applied thereto in the usual manner, whereby the points of the pen may be adjusted, these points being adapted to be brought together under the spring resistance of one or both of said legs, as usual.

The shank *c* has a hole drilled through it axially to receive the feed-tube *h*, the inner end of which is substantially flush with the threaded end of the shank, onto which the handle of the pen is screwed, and the end of the tube is sealed therein in any desirable way, as by the packing *i*. This tube *h*, emerging from the shank, passes down between the two legs of the pen and has a curve *j* formed in it to allow it to pass around the adjusting-screw without interfering with the functions of the latter, and the end of the tube is flattened, as shown in Figs. 1 and 6, to permit the two points of the legs to be adjusted toward one another without contacting with the tube. The end of the feed-tube *h* is located at some distance above the points of the pen, and the space between these points and the end of the tube constitutes the ink-space. The feed-wire *k* is located in the tube *h* and extends from the point of the pen somewhat beyond the inner end of the feed-tube and into the ink-reservoir *b*, and that end of the wire lying between the pen-points is flattened, as shown in Figs. 2 and 6, and is bent slightly to one side to bring its flattened point against the point of the movable or pivotal leg. As the wire fits loosely in the feed-tube, the adjustment of the pivotal leg will move the wire more or less within the delivery end of the tube, thus keeping clear this end, which is somewhat restricted in area by being flattened, and thus insures a freer delivery of ink. The wire *k*, being forced into the feed-tube after the latter is bent around the screw *g*, is held in any position relative to the pen-points by reason of the bend formed therein, as it is passed through the bend in the tube, wherefore this frictional engagement is sufficient to hold the feed-wire against endwise displacement without the aid of additional fastening means, thereby simplifying the device.

To permit the free flow of ink to the pen-points through the feed-tube *h* when it is desired to fill the pen for use, means are provided for admitting air into the upper closed end of the reservoir *b* above the level of the ink, which consists in boring a small hole *m* through the wall of the reservoir and fitting thereover a cap *n*, the upper end of the reservoir being turned down to receive this cap without enlarging the diameter of the reservoir. Through the wall of the cap *n* another small hole *o* is drilled adapted to be brought into registration with the hole *m* to vent the upper end of the ink-reservoir.

Geo. R. Pyne, Springfield, Mass., is the inventor.

Drawing Board.

This invention relates to drafting, and more particularly to that class of devices thereunder known as "drawing-boards;" and its object is to provide a device of this character which shall be simple in construction and of great utility to the draftsman.

Figure 1 is a perspective view of a table embodying the invention. Fig. 2 is a plan view of a portable board, showing the slot-cover in place. Fig 3 is a plan view of the slot-cover. Fig. 4 is a section on line 4 4, Fig. 1. Fig. 5 is a cross-section of the slot-cover. Fig. 6 is a section on line 6 6, Fig. 2. Fig. 7 is a similar view with the parts separated.

The letter B designates the board or tabletop proper. It is essential to this invention that the space below the board shall be open. Hence in Fig. 1 the board is illustrated as being supported on a spider *s*; but it will be understood that the board may be made in the portable form shown in Fig. 2 and supported in any desired manner. The upper surface of the board is shown as being covered by some suitable sheet material *c*; but this covering may be omitted without departing from the spirit of the invention. The board is provided with a slot S, which may be located, as preferred, within the periphery of the board. As clearly shown in Fig. 4 the opposite side walls W are beveled at *w* and *w'* on their upper and lower edges, respectively, forming sharp ruling edges *e*. We prefer to cover these ruling edges with brass *m*, secured along one edge beneath the covering and at the other edge to the lower bevel. Each upper bevel is in a plane substantially parallel to, but spaced from the plane of the opposite lower bevel in order to enable a tablet or slate to be firmly held between them while lines are being drawn on its surface.

The operation will be readily understood by referring to Fig. 1, in which

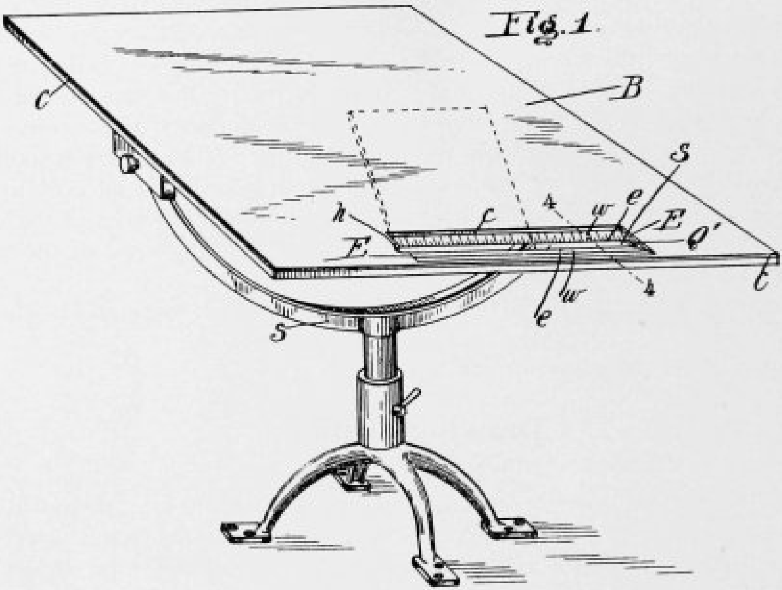
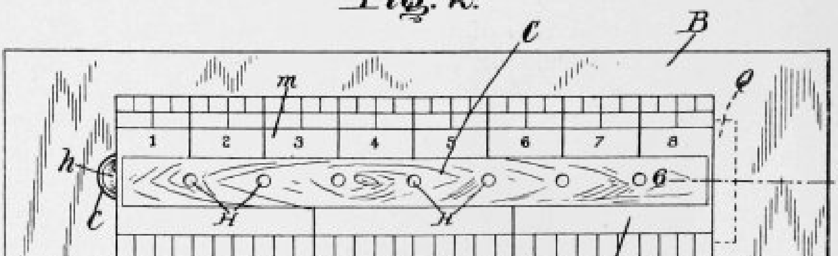


Fig. 2.



a tablet is indicated in dotted lines as resting against one of the end walls E of the slot and braced by the bevels on the side walls. These end walls are accurately squared and preferably brassed, so that a series of parallel transverse lines may be quickly drawn on a suitable surface by slipping it up or down in the slot and using the exposed ruling edge at the desired points.

In Figs. 3 and 5 is illustrated a slot-cover C, which is used in connection with the board. This cover is suitably beveled, as at *b*, upon its lower side edges, so as to fit accurately within the slot with its upper surface exactly flush with the face of the draw-

Fig. 3.

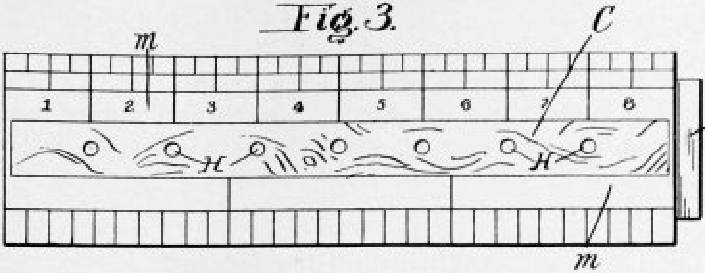


Fig. 4.

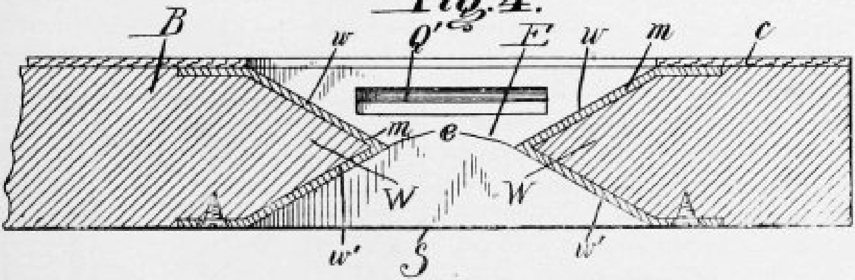
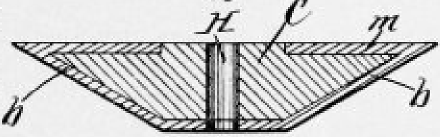


Fig. 5.



ing-board. One end of the cover is provided with a projecting tongue Q, which has in cross section the form of a lower quadrant of a circle—that is, it has a flat upper face and a curved lower face. The adjacent end wall of the slot has formed therein a socket Q', also quadrant-like in cross-section, which is adapted to receive the tongue Q. The opposite end wall has a thumb-hole *h* for convenience in lifting the cover. This form of tongue and socket is considered of great value because the flat upper faces of the quadrants form a secure bearing-surface preventing tilting of the cover, while the curved lower face permits its removal without danger of breaking the tongue or enlarging the socket.

Fig. 6.

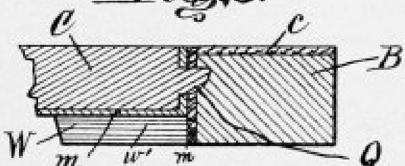
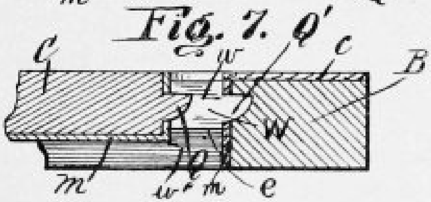


Fig. 7.

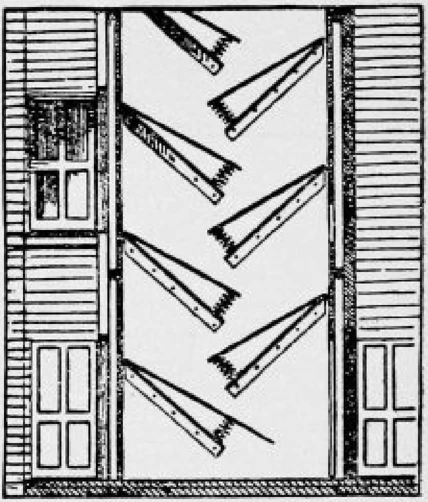


It is obvious that the slot-cover may be employed as a separate ruler, and it may have scales of different standards engraved upon its faces. In like manner the side walls of the slot are furnished with suitable measuring-marks. The cover may also be provided with a series of holes H, which adapt it for use as a sort of beam-compass, as will be readily understood, by inserting chalk crayon, or pencil-lead through one hole to mark with and by inserting the rubber-tipped end of the pencil through another hole to be used as a center, yet without making a mark.

Jacob Shellhammer, Isaac P. Henthorn and Wm. A. Hill are the inventors.

A Unique Fire Escape.

Here we have a fire escape, invented by Philip H. Dedrick, of Grandview-on-Hudson, N. Y., which stands in a class alone as far as novelty is concerned, having a unique feature which has probably never before been applied to the work of saving people from burning buildings. As will be seen, the idea is to erect a series of rigid platforms alternately on opposite sides of a well inside a building or between two buildings, setting each platform at such an angle that anything sliding from it will strike on the next platform, at right angles to the first. This of itself would break the force of a fall, and a person would drop from the roof to the ground with no more serious injury than a severe shaking up; but the inventor has placed a spring cushion on each of these platforms, which would reduce to a minimum the jar occasioned by a fall from one platform to the next. As a person drops on one of the cushions it yields beneath his weight, and then discharges its burden to the next cushion, and so on, until the bottom



FIRE ESCAPE.

of the well is reached, when the person picks himself up and makes his escape through one of the exit doors provided, none the worse for his fall.

Book Notices.

The writer of "Stair Building Made Easy" has a good remark in his introduction, that so many books on the subject are written by men who do not seem to think it necessary to begin at the beginning and teach the young workman how to build a stair of the simplest kind and then lead him up step by step until he is able to erect and complete stairs of better description.

This cannot be said of this book, and that it has other attractive features is found in the fact that this is the third edition, enlarged and revised greatly and still at the same price, $1.00.

While it is intended as a book for the workman yet it is quite valuable to the architectural draftsman, since everything is discussed in a very practical manner.

The book is published by The Industrial Publication Co., 16 Thomas street, New York, N. Y.

The student in Physics, or any of our readers who are interested in experimental work, will appreciate a copy of "Practical Measurements in Magnetism and Electricity," written by Mr. Geo. A. Hoadley.

The purpose of the book is to meet the requirements of students in scientific courses, as well as those of the practical man who wishes to become familiar with the foundation principles of the subject.

The student will need some apparatus and he may be able to add to it by building some of his own design, but in the end, if careful in keeping notes, etc., he will be much advanced in the subject.

The book is 5x7½, with 110 pages, cloth covered board backs, and well illustrated and printed. Price ——. Published by American Book Company, Cincinnati, O.

Self-Propelled Vehicles: A Practical treatise with illustrations, by J. E. Homans, A. M., 8vo, pp. 672, bound in black vellum, gilt top, gold titles. Theo. Audel & Co., Educational Booksellers, New York. Price, $2.00.

In presenting the new edition of this work, the publishers announce that the book has been thoroughly revised, and in large part rewritten.

There is a vast amount of useful information packed into its 644 pages and it is so well arranged and so clearly stated that the reader cannot fail to find and comprehend the information given.

The general principles of automobile construction and operation, including steering devices, underframes, wheels, tires, bearings, and lubricators are included in the opening chapters. Then follows an exhaustive account of the theory, construction and operation of gas engines, occupying over 100 pages. Several typical engines are taken up and discussed separately, and their properties, as regards balance, speed and power, are discussed in the light of fundamental principles. The explanations of the governing devices are clear and valuable, while the discussion of ignition, including the hot-tube, and the primary and secondary sparks, cannot fail to prove of the utmost value.

Probably the most interesting feature of the entire work is the extensive chapter devoted to the description of leading types of gasoline vehicles, including the most important of American build. In this chapter the reader is informed as to the details of the transmission and control apparatus in each case. The chapters on electric vehicles are also full and certain to prove of practical use to the owner and chauffeur. Taking the subject of electrical apparatus from the fundamental principles of circuits and batteries, the discussion passes to the theory and operation of generators and motors; the laws of motor operation; the laws involved in computations of speed and power, and the varieties of motor suited to road carriages. Electricity meters are described and illustrated in a brief chapter, and the principles underlying storage batteries, their construction and care, are outlined.

All necessary information is given, and the merits of several types of steam carriage are fully set forth.

"Modern Estimator and Contractors' Guide for Pricing All Builders' Work," by Fred T. Hodgson. Bound in cloth, 250 pages. Price, ... Frederick J. Drake & Co., Publishers, Chicago.

The book that attempts to give exact figures as to the estimates of building will be often in error, because of the ever changing prices of material and labor.

There are, however, certain rules and constants of measurements the estimator may use which may be re- ed upon as being correct, and it is the aim of the writer of this column to show these facts in an understandable manner.

The main factor to be employed in estimating is experienced judgment and without it no estimator can expect any great degree of success.

Great pains have been taken to collect such exact information as may be useful in estimating, either in the office or on the building, with the object of forming what is believed will prove a valuable addition to building literature aside from simply a price book.

A man with an aim will sooner or later be a man with a name.

FACTS ABOUT GLASS.

The oldest specimens of glass, says an authority on curious information, are traced back from 1,500 to 2,500 years before Christ. These are of Egyptian origin. Transparent glass is believed to have been first used about 750 years before the Christian era. The Phoenicians were supposed by the ancients to have been responsible for the invention, and the story will be recalled of the Phoenician merchants who, resting their cooking pots on blocks of natron, or subcarbonate of soda, found that the union, under heat, of the alkali and the sand on the shore produced glass. There is little doubt, however, that the art of glassmaking originated with the Egyptians. It was introduced into Rome in the time of Cicero, and reached a remarkable degree of perfection among the Romans, who produced some of the most admirable specimens of glass ever manufactured; an instance is the famous Portland vase in the British Museum. Glass was not used for windows until about A. D. 300.

HUNDRED MILES AN HOUR.

The first of thirty electric locomotives being built by the General Electric Company for the New York Central Railroad has been completed, and will be tested before the remaining twenty-nine are built. The New York Central has given the use of one of its freight tracks near Schenectady for the test. A third rail is being laid to carry the electric current, which will come from a specially constructed transformer station. Six hundred volts will be used.

THE DRAFTSMAN

Devoted to Drafting, Illustrating and Home Study,

PUBLISHED MONTHLY AT CLEVELAND, OHIO.

Moment of Inertia and Flexture.

By John S. Myers.

Since receiving bound volume for 1903, the writer has been looking over same and wishes to offer comment on the article entitled, "Moment of Inertia, Radius of Gyration and Flexure," which appeared in the January issue, 1903.

The article states, in reference to Fig. 1: "Thus it is evident that the force acting upon a particle at the top

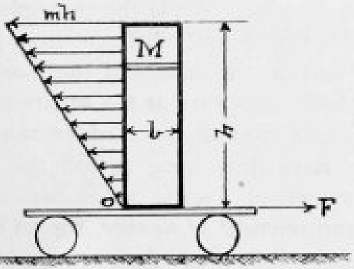


FIG.1.

is greater than the force acting upon a particle near the bottom," but does not explain why it should be evident. To illucidate the subject of moment ot inertia, one must go back and define *inertia.* Inertia is the inability of matter to alter its condition of motion.

It requires force to set matter in motion; it requires force to stop matter when it is in motion. Matter in motion must therefore possess energy. The amount of energy it possesses is in proportion to its mass and the square of its velocity, and is exactly equal to the work done upon it in imparting the motion, since it has no power of its own whereby it can change its condition.

In Fig. 2, if the distance *h n* be twice as great as the distance *h*, then *M n* must move twice as far as *M*; i. e., n:d::hn:*dn*, as the distances passed over are proportional to the distance from the point of rotation. It follows that the velocities is also proportional to the distance *h*, *hn*, for the motion imparted is in equal intervals of time.

Since energy is in proportion to the square of the velocity, the energy possessed varies as h^2, h^2n, etc.

Energy is the product of a force and the distance through which it acted;

thus $E = fd$ and $f = E$, where $E =$ Energy, $f =$ the acting force and $d =$ the distance through which it acted. The force of M acted through the distance d, and the force of Mn through the distance dn. Hence, $f = E$ and fn

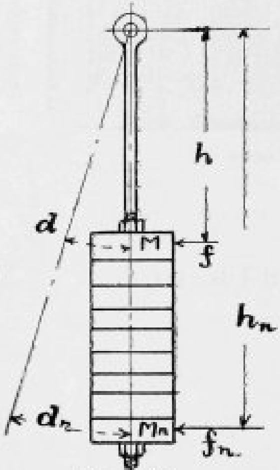


FIG. 2.

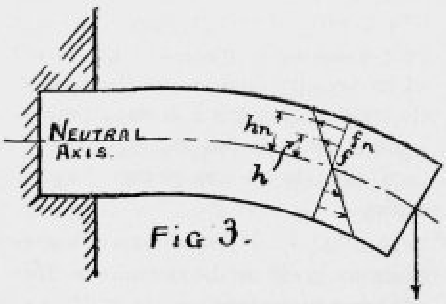


FIG 3.

$= En$. Since E and En vary as h and hn and since f and fn vary *inversely* as d and dn, d and dn being proportioned to h and hn, it follows that $f : h :: fn : hn$. That is to say, the force or inertia of the mass is directly proportional to the distance from the point of rotation.

Now, the moment of a force is the product of that force and the length of its lever arm, thus the distance from the point of rotation enters as a factor twice when calculating the moment of inertia, and this moment is then proportional to h^2, h^2n, etc.

In flexure one is treating quiescent loads; mass and velocity do not enter as factors; hence, inertia is not a factor in the strict sense of the term.

The first principle in flexure is, that stress and strain are proportional, i. e., if a load of one ton elongates a rod 1-100 of an inch, a load of two tons would elongate the same rod 2-100 of an inch, providing the elastic limit were not exceeded.

When a beam is loaded it deflects or bends, the fibers are elongated or compressed in proportion to their distance from the center, and it is for this reason that the forces vary as the distance h, hn, etc. At the center they are neither elongated nor compressed, this line has been termed the neutral axes.

Now, the magnitude of the force being proportional to its distance from the axes and its moment being equal to the magnitude times the distance; distance (h, hn, etc.) enter twice as a factor, making the moment of forces induced by flexure vary as the square of the distance. While the principles involved are entirely different from those of inertia, the values of the moments in both cases vary as the square of the distance from the point of rotation and we have thus come to use the term *moment of inertia* when we really mean *moment of flexure*, for no other reason than that they are equal in value.

If text-books used the more logical term, considering inertia and moment due to it along with mass, velocity, energy and work, the subject would be much easier to grasp. In other words, call a thing by its right name.

Editor *The Draftsman*:—

The writer is of the opinion that an erroneous idea is conveyed in the article on "Beams and Planes Severally Supported and Loaded," appearing in the August issue of *The Draftsman.*

For formulaes 6, 7 and 8, in reference to Fig. 2 of the article, to be applicable one must assume the beam to be *inflexible* and the reactions *uniformly elastic.* Elasticity is one of the general properties of matter, therefore, all beams, when loaded, will deflect. The foregoing then becomes an impossible condition. Fig. 1 illustrates the nearest approach to these conditions in a practical sense.

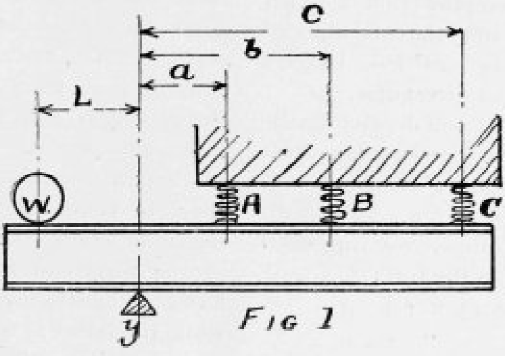


FIG 1

Taking the beam *xx* as being loaded to but a small percentage of its ultimate safe load, thus reducing flexure to an inconsiderable factor, and the reactions *A*, *B* and *C*, as being produced by springs of equal strength and elasticity.

It is evident that the distortion (compression) of the springs *A*, *B* and *C*, is proportional to their distance from the point of rotation *y*, and since stress is proportional to strain within the elastic limits, the forces at *A*, *B* and *C*, are also proportional to their respective distances from *y*. Since the magnitude of each force and its moment are each proportional to its distance from the point of rotation, it follows that its moment, or torque, is proportional to the square of this distance; hence torque, or moment, due to spring.

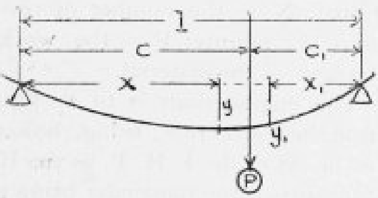
$$A = \frac{a^2}{a^2+b^2+c^2}$$

$$B = \frac{b^2}{a^2+b^2+c^2}$$

$$C = \frac{c^2}{a^2+b^2+c^2}$$

of the total torque *W L*.

If, however, the reactions *A*, *B* and C be practically rigid in comparison to the beam, which is usually the case, the entire load would be concentrated upon *A* by reason of the beam's deflection.



If the relative elasticities of the

beam and the several reactions be known, their resulting magnitudes, moments, strains, etc., can be determined, but in practice such constructions are usually avoided as inaccuracy of workmanship, unequal settlement, or some other equally practical reason, would usually make the problem undeterminable; in fact, it would be practically so, even assuming theoretical conditions, if the system of loading were at all complicated, as one would have to take into account the elastic curve of the beam; the equation of which, even for a simple beam follows:

$$Y = \frac{p}{j\,e}\,\frac{c^2\,c_1^2}{6\,l}\left\{2\,\frac{\cdot}{c} + \frac{x}{c^1} - \frac{x^3}{c^2\,c^1}\right\}$$

$$Y^1 = \frac{p}{j\,e}\,\frac{c^2\,c_1}{6\,l}\left\{2\,\frac{x^1}{c^1} + \frac{x^1}{c} - \frac{x_1^{\,3}}{c_1^{\,2}c}\right\}$$

Where I = the movement of inertia of the section and E = the modulus of elasticity.

—*John S. Myers.*

Shafting for Marine Engines.

Carl H. Clark.

The principles governing the size of shaft for marine work are the same as those well known for stationary power work with the exception that a much larger factor of safety must be allowed since the stresses are less exactly known and far more irregular.

The size of shaft will depend directly upon the horse power transmitted and upon the number of turns per minuet. The general formula for the diameter of a uniformily rotating shaft may be reduced to the form

$$\text{Dia.} = 68.43 \times \sqrt[3]{\frac{\text{h. p.}}{\text{f} \times \text{n}}}$$

where H. P. = the horse power transmitted; N = the number of revolutions per minute; F = the working strength of the material.

The engine shaft is to be figured from the above rule, using, however, .80 or .85 of the I. H. P. as the H. P. transmitted, the remainder being used up in engine friction, etc.

The working stress of the material is about as follows: For compound engines, 3,000; for triple engines, 3,750. These values will be seen to be low corresponding to a factor of safety of nearly 20. This, as said before, is to allow for unknown stresses, and to give sufficient diameter to allow ample bearings. The main bearings are customarily made from 1. to 1.2 x diameter in length, with two to each crank. The crank pins are usually the same diameter as the shaft, and of a length epual to 1. or 1.1 x diameter. The engine or crank shaft may be either of the forged or built up type, the former is mostly used in naval vessels, while the latter is nearly always used in mercantile work, as it is somewhat cheaper and easier to repair. The crank-shaft is made in sections, usually one to each crank. It is of advantage to have these sections interchangeable, as then a single spare section will replace any of the others. The forged crank shaft, as shown in Fig. 1, is usually combined with a hollow shaft, the slabs in this case are from .65 to .70 times the shaft diameter, with a thickness of about 1.1 times diameter of shaft. It will also be noticed that the corners of the slabs are chamfered off to save some weight without detracting from the strength.

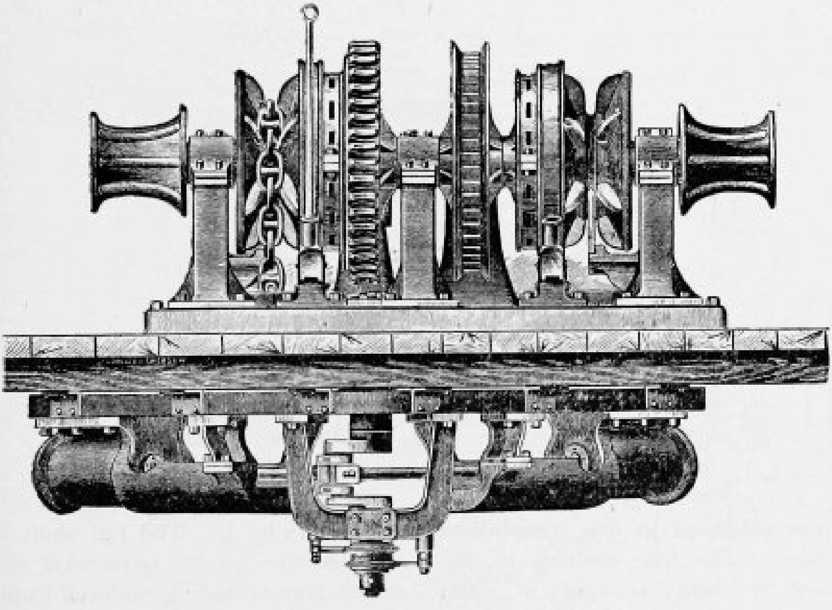
In case of the built-up shaft as Fig. 2, the parts of the shaft and the pins are shrunk and keyed in place; this necessitates that the slabs should be both thicker and wider, thickness being up to .75 of the diameter of shaft, and the width nearly two times the diameter. This construction allows a defective crank pin or portion of shaft to be replaced without discarding the whole section.

The several sections of shaft are fastened together by forged couplings and bolts. The thickness of these couplings is about 3. the shaft diameter, and of sufficient diameter to accommodate the coupling bolts.

The usual diameters of coupling bolts are from 1 1-2 to 3 1-2 inches, and the number from 5 in small shafts to 12 or more in large ones, the between number and diameter of bolts is obtained from the turning movement, as

$$\frac{.196\ D^3}{N \times R}$$

when D = dia. of shaft, N = number of bolts, and R radius of bolt circle. Coupling bolts may be either straight or tapered to about 1-2 inch to the foot, in which latter case no head is required- The threaded part of the bolt may be made smaller than the body, as the nut merely holds the bolt in place. Fig. 3 shows a section through flange.



The thrust shaft is the same diameter as the engine shaft, and is provided with collars to engage the thrust rings.

The area of these collars must be sufficient to keep the thrust pressure down to about 50 lbs. per sq. in.

The line shafting may sometimes be a trifle smaller than the crank-shaft.

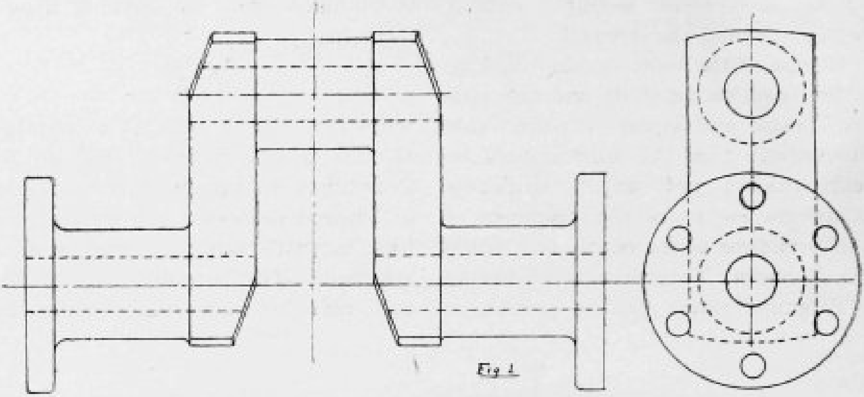


Fig 1

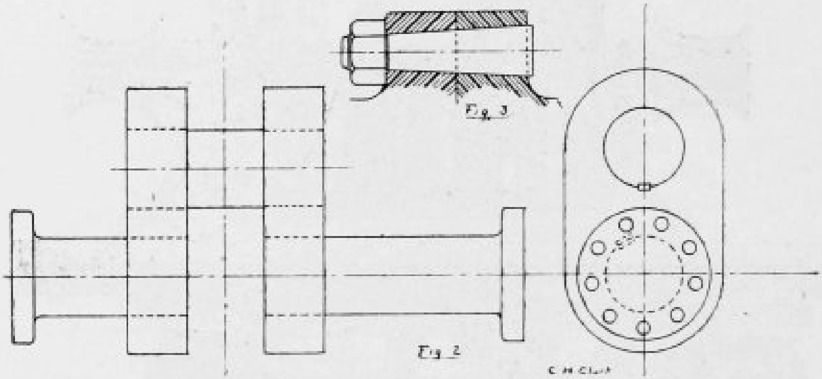


Fig 3

Fig 2

as it is subjected to less complicated stresses. The line shafting is supported by steady bearings at short intervals, and is subjected solely to twisting stresses.

The propeller or tail shaft is made larger than the engine shaft, as it is severely strained by the action of the propeller. This increase is sometimes required to be $\frac{1}{20}$. The tail shaft inside the stern tube is covered with some water-excluding material to prevent corrosion by galvanic action.

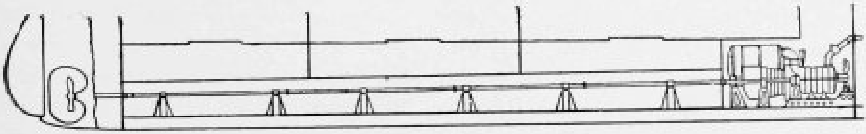
The entire line of shafting must be made of the very best material, and very carefully inspected during the forging and machining.

First Ocean Turbine Steamer, Victorian.

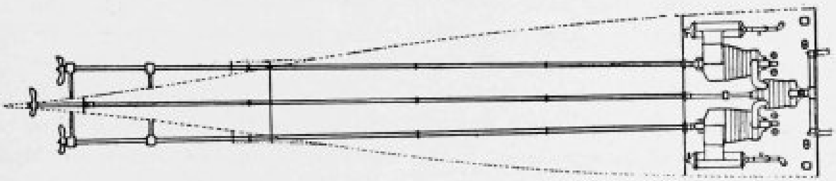
By Frank C. Perkins.

THE first ocean steamer to be equipped with steam turbines has recently been launched at the Belfast ship yards of Messrs. Workman, Clark & Co. This huge vessel, shown in outline in the illustration, is the Allan liner Victorian. At this launching, 10,000 tons of steel was transferred from land to water, which cost about ¾ of a million dollars. This vessel has very great depth for her beam as is noted when it is stated that it is 74 feet from the keel to her flying bridge. Her total length is 540 feet with a breath of 60 feet. She is divided by bulk heads into 11 compartments and with the subdivisions of her double bottom she has 20 water tight spaces. The three propellers are of manganese bronze, each being operated by a steam turbine at a speed of from 270 to 300 r.p.m. One of the special features of this type of boat is the small propeller and the direct drive by the steam turbines which gives a smooth motion even at very high speed.

This steamer was originally designed to be operated by triple expansion marine engines of the reciprocating type but after the hull was partially constructed it was decided to install the modern steam turbine for the motive power and about this time there was considerable discussion as to whether the steam turbine would be practicable as a means of propelling the great ships that carry the Transatlantic passenger traffic. The keel of the Victorian was laid somewhat less than a year ago and it is expected that before the end of the present year she



SECTIONAL ELEVATION.



PLAN VIEW.

will be ready for sea, when it is certain her trial trip will be watched closely by marine engineers and by many companies which have decided to adopt steam turbines for their new liners. The Parson's steam turbine was the type decided upon, two low pressure turbines and one high pressure turbine being required to operate the three propellers. The high pressure turbine drives the central propeller as in a single screw vessel while the low pressure turbines work the others as arranged in a twin screw steamer. The low pressure turbines are provided with a reversing arrangement which will allow them to be driven at full speed astern either independently or together which will allow the vessel to be easily and effectively manoeuverd backing and turning as readily as with an ordinary twin screw steamer, thus doing away with the objection heretofore urged against steam turbines for driving large vessels, that they were defective in regard to reversing the propellers. These steam turbines are being constructed by Workman, Clark & Co. under an arrangement with Messrs, Parson's & Co. of Newcastle-on-Tyne. The heavy steel casing and drum of each of low pressure turbines weighs nearly 200,000 pounds while the blades both fixed and moving are so small and delicate as to make a remarkable contrast and it seems almost impossible that the steam working on these little blades even in such large numbers can send a great ocean steamer through the sea at a speed of 25 miles per hour but that is what they are expected to do.

The steam for these turbines is to be generated by 8 large boilers constructed at the same works and shops at the Belfast ship yard. The turbine steamer Victorian is intended for first class Canadian mail service and has a capcity for 8000 tons of cargo and possesses accommodations for 1300 passengers with 8 decks, 6 of which are for the use of passengers, her promenades being unusually fine, and the music room, dining room, cabins, and other special accommodation being of the highest grade. The staterooms and other suites of rooms are perfectly ventilated and heated, and the first-class smoking room is most luxuriously equipped, while the second class quarters are not less comfortable proportionately, and the third class passengers are catered for in the most liberal manner, electric lights being utilized throughout, a complete printing outfit being provided on board as well as an installation of Marconi wireless telegraphy.

Within a few months the steamer Victorian will have settled the question as to whether steam turbines are successful for ocean liners and are well adapted for these services.

HOME STUDY.

Course II.--Mechanical Drawing.

CHAPTER IV.

Shafting and Forgings.

A large proportion of machine parts are made from metal castings, formed by the aid of a wooden pattern.

Another class of parts is made by forging or rolling from steel or wrought iron billets. Pieces made in this way are used where lightness, toughness and great strength are necessary. They are usually more simple in construction than castings; they are also more costly to manufacture.

Engine crank shafts and connecting rods are familiar examples of machinery forgings. Line shafting is made of rolled steel. In cold rolled shafting the metal is brought to nearly the right size in roughing rolls; it is then run cold, back and forth through finishing rolls until the right diameter is reached.

The effect of this process is to give the shaft a very hard and close-grained "skin" or finish with a soft and flexible core inside.

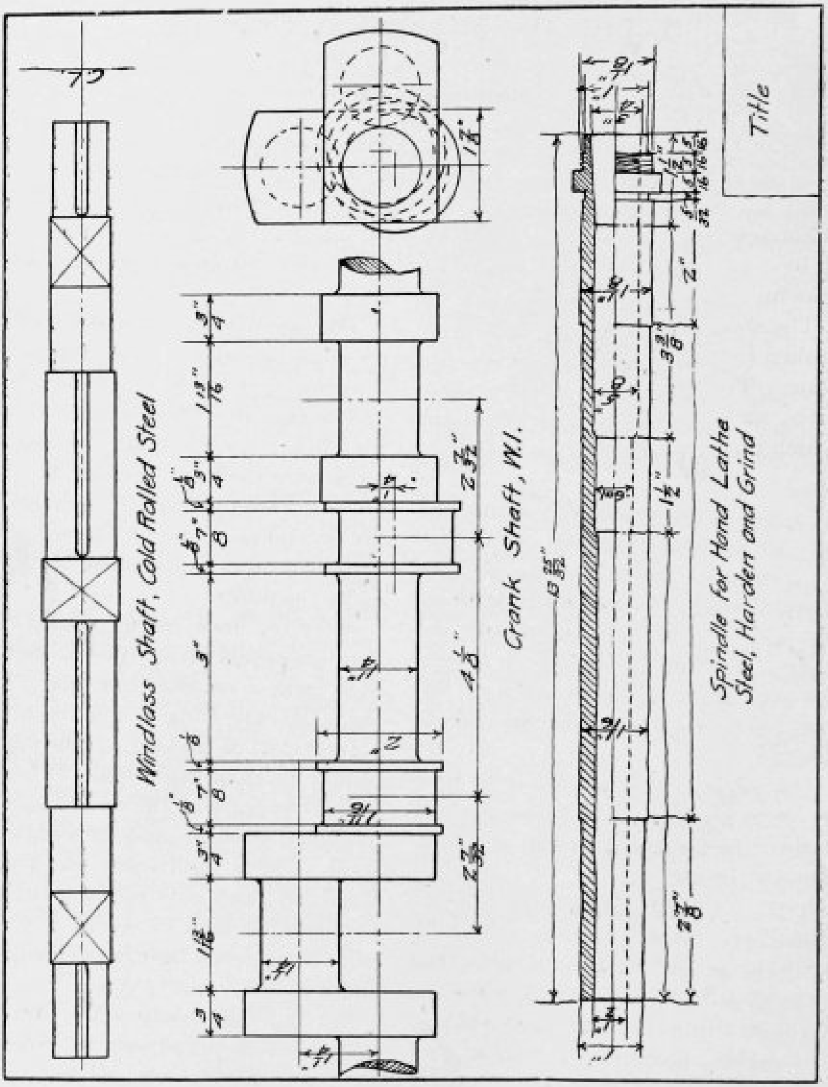
The so-called structural shapes which are used to some extent in machine design, are formed from the billet by shaping rolls which press the hot metal into the standard shapes, like angles, channels, I beams, and so on.

The young draftsman ought to learn these standard shapes and their sizes, so that he can use them readily. The hand books published by the Carnegie, Jones & Laughlins, or Cambria steel companies, contain a great deal of useful information on this subject, and the student is advised to get one of them.

The sketches shown with this chapter all of forgings. In laying out the drawing, first locate the center lines, and be sure that there is room enough for all the views, then lay out the piece from the data given. If there are two views, work them together, for mistakes made in drawing one view will often be found in trying to make the other.

After the lines are all drawn, put the dimensions on in pencil and go over them a second time and check up. This checking is the most important part of making a drawing; it should never be neglected. It is convenient to mark a dimension after it has been checked and proved to be right. Most draftsmen use a small V-shaped mark with pencil or red ink. It is possible then to see at a glance what dimensions have been compared and what have not.

Putting dimensions on a drawing properly is acquired only by practice. Beginners hardly ever get on figures enough. "Does the mechanic need this dimension in order to make the piece?" is the question to be asked in regard to every figure put on. Put on a dimension for each change of outline. Where there is a row of dimensions the whole length of the object, keep them in line. Then put on an over-all dimension equal to the sum of all the smaller ones. Keep figures outside of the outline of the object as far as possible.



PROBLEM I.

Make a detail of the windlass shaft shown. Make a side and an end view showing the position of keys. The dimensions of the shaft are as follows: 7′ 4″ long over all; 4″ diameter at middle journal. Journals 6″ long, center of middle one in center of shaft; center of end journals 15″ from end of shaft; diameter of end journals $3\frac{7}{8}''$. On each end of the shaft is a drum having a $12''\times3\frac{3}{4}''$ bearing. The drum is fastened to the shaft with a gib key of proper dimensions. Inside of and close up to the end journals is a chain wheel having an $8''\times3\frac{7}{8}''$ journal. The chain wheel is to have a running fit on the shaft. On each side of the middle journal is a bearing for the worm and ratchet wheels which drive the shaft. Each bearing is $15''$ long $\times3\frac{13}{16}''$ diameter, fitted with a key of proper dimensions, and turned to a fit such that the wheels can be forced on by hydraulic pressure. Scale of drawing, $3''$ to $1'$.

The shaft will have to be shown broken in several places to go on the plate. The cut shown on page 446 gives an idea of the machine from which this was taken.

CRANK SHAFT.

PROBLEM II.

Make two views of the engine crank shaft shown in Fig. 2. In the end view, be careful to locate the center of the eccentrics right, with reference to the centers of the cranks. Scale full size.

PROBLEM III.

Lay out to a suitable scale the lathe spindle in the sketch, Fig. 3. Dimension completely, somewhat as shown. Indicate standard threads, and show by notes the kind of fits required. In lettering and figuring drawings, adopt some plain letter and stick to it until a style is acquired. The letter shown is recommended as being about the simplest and most readable.

Strength of Shafting.—From mechanics we know that

$$D=\sqrt[3]{\frac{5.1T}{S}} \qquad (1)$$

Also it can be shown that

$$T=\frac{63025\ H.P.}{N} \qquad (2)$$

Now if we substitute this value of T in the first formula we get

$$D=\sqrt[3]{\frac{321000\ H.\ P.}{SN}} \text{ nearly.} \qquad (3)$$

We may give S the following values; 45,000 for common turned shafting, 50,000 for soft rolled iron or steel, 65,000 for machinery steel. For line shafts and counters, we should use the first of these values. The second would answer for forged pieces. For places where good wearing qualities or durability is necessary, as for example lathe spindles, use machinery steel. These values represent the ultimate or breaking strength of steel per sq. inch, but no engineer ever thinks of using as high a value as this in practice. It is customary to use factors of safety as follows: Head shafts, 15; line shafts, 10; counter shafts, 6.

A factor of safety is a number by which the breaking strength is divided to obtain the safe strength. Symbols used in this chapter:

T=Twisting moment in lbs. inches.
N=Number of revolutions per min.
$H.P.$=Horsepower.
S=Strength per sq. in. of metal.
d=Diameter of shaft in inches.
D=Diam. of driving pulley or gear.
P=Force applied at rim.

For further discussion of the subject see Benjamin's notes on Machine Design.

QUESTIONS.

1. What is cold rolled steel, and what is it used for?

2. What are the stock sizes of

ordinary shafting from ½" to 4" diameter?

3. About three grades of steel are commonly recognized—hard, mild and soft. State for what purpose you would use each in designing machinery.

4. Can you weld a piece of mushet or stubbs steel? It not, why?

5. Suppose you had to true up the dead center in a lathe, how would you go about it?

6. Describe the process of making drop forgings.

7. Describe briefly the Bessemer process of making steel.

8. How are heavy engine crank shafts made?

9. How much allowance ought to be left for the finish in iron forgings?

10. What is the effect of heat on steel?

11. What would be the cost per foot of the shafting in question?

12. How many horsepower would the windlass shaft in the sketch transmit safely?

13. How many revolutions would the engine have to make in order to transmit 10 H.P.? S = 50,000.

14. How large a shaft would you put in a shop where there was 20 H.P. to transmit and where the shaft made 150 R.P.M.?

15. Describe the Process of rolling steel from the bloom?

MECHANICS.

Work and Power.

CHAPTER IV.

WHEN anything exerting a force produces any effect on a body, and the object acted upon moves in the direction of the force, then the thing exerting the force is said to *do work*.

For example, a man does work in lifting a pail of water; gravity does work on the weight of a pile driver, causing it to descend when released; the electric current by means of the motor, does work when it runs the elevator and thus lifts a weight through space.

Unless the object moves in the direction of the force, no work is done no matter how great the force may be, hence we may consider *work* as the overcoming of resistance, and the amount of work done is measured by the resistance overcome, multiplied by the distance through which it is moved. Then the work done is not measured by the amount of resistance or the distance moved, but by the product of the two, which is called the unit of work.

There are three units of work in common use:—

(1) The *foot-pound*, or the work done by a force of one pound working through a space of one foot. It is the unit most used by English-speaking engineers, but it is open to the objection that it is variable, on account of the variation of the weight of a pound with the latitude.

(2) The *Kilogramme-meter*, or the work done by a force of one kilogramme working through a distance of one meter. This is the unit of work in the metric system, and is

open to the same objection as the foot-pound.

(3) The *erg*, or the work done by a force of one dyne working through a distance of one centimeter. The erg is the absolute unit in the metric system, and is invariable.

Gravity gives to a gramme in a second a velocity of about 980 cm. a second. It is therefore equal to 980 dynes

If then, a gramme be lifted vertically one centimeter, the work done against gravity is 980 ergs, or one erg of work is done in lifting $\frac{1}{980}$ gm. 1 cm. high.

A silver dollar weighs about 26.73 gm, and the height of an ordinary table is about 76.3 cm., then the work done in lifting the dollar to the table top is the product of 26.73, 76.3 and 980, or 2,000,000 ergs nearly. Hence an erg is a very small unit, and a convenient multiple is used called a *joule*, or 10,000,000 ergs.

Time and Work, It necessarily takes time to do work, but the amount of work done has nothing to do with the the time taken to do it, To lift the dollar requires 2,000,000 ergs of work, whatever the time consumed in lifting it.

A man weighing 150 lbs, walks up the 900 steps leading to the highest point in the Washington Monument, 500 feet high; he does work against gravity equal to 75,000 foot pounds without regard to the time taken in going up.

When the work done in a certain time is divided by the time, a time-rate of doing that work is obtained, called *Power*. The power of an agent depends upon the amount of work done in a unit of time. Then the unit of power would be a certain number of units of work in a unit of time.

In the English gravitational system the unit of power is the horse power (H.P.); it is the rate of doing work equal to 33,000 pounds raised one foot high in a minute, or 550 foot pounds per second.

In the centimeter-gramme system, the unit of power is the *watt*. It equals work done at the rate of one joule (10,000,000) ergs a second, One horse-power is equivalent to 746 watts.

A kilowatt (K.W.) is 1,000 watts, which is nearly ‹ h.p.

To convert kilowatts into horse-power, add one-third; to convert horse-power into kilowatts, subtract one-fourth.

For example, 60 K w. equal 80 h.p., and 100 h.p. equals 75 K.w.

PROBLEMS.

1. A man whose weight is 150 lbs, walks up a height of 6,288 feet. How many foot-pounds of work does he do? *Answer.*—943,200 ft. lbs.

2. A horse exerting a force of 100 lbs. pulls a load of 1,000 lbs, up a hill 100 ft. high. How much work is done? How long is the hill? *Ans.*—100,000 ft. lbs.; 1,000 ft.

3. A stone weighing 5 K.m. is carried to the top of a building 25 m. high. Calculate the amount of work done.

4. Which does the most work, a man who carries a ton of coal to a height of 40 ft. in two hours, or a man who carries two tons of coal to a height of 10 ft. in four hours? *Ans.*—80,000 and 40,000 ft.lbs. respectively.

5. A man can pump 25 gal. of water per minute to a height of 15 ft., how many ft. lbs. of work does he do in a day of 10 hours? *Ans.*—1,800,000 ft. lbs.

6. In a town of 15,000 inhabitants, each person uses water at the rate of 50 gals. per day. If the water has to be pumped to a height of 200 feet, what is the horse-power of the pump?

7. A man whose weight is 160 lbs. carries 60 lbs. on his back and climbs a ladder to a height of 40 ft. in 1 1-2 minutes. Find first his power in ft. lbs., second, as a fraction of a horse-power, and third in watts.

8. At what rate is an engine working which raises 2,000 tons of coal per day from a pit 250 ft. deep?

9. A tank of 1,000 gal. at an elevation of 50 ft. is filled with water in two hours by a pump. Calculate the horse power.

10. Measure up some engine that you have access to and calculate the horse power. (Class room engine to run at 200 revolutions, with mean effective pressure of 50 pounds per sq. inch.

Questions.

1. Find the proper thickness of a cast iron water pipe 6″ in diameter. s=18,000 factor of safety 6. Pressure 200 lbs. per square inch. Does this result agree with practice? Why?

2. A standard lap welded steam pipe 8″ inside diameter is .32″ thick. It is tested to an internal pressure of 500 lbs. per sq. in. Find the bursting pressure and the factor of safety above the test pressure. s=40,000.

3. Calculate the thickness of the following size of pipe and compare with amounts given in the tables of pipe sizes. (Kent, page 194.) Use formula given in this chapter.

2″ pipe nominal inside diameter.

3″ pipe nominal inside diameter.

4″ pipe nominal inside diameter.

5. If one square foot of radiating surface is required for each 75 cubic feet of space in a room, find how large a room can be efficiently heated by any (See Kent, p. 537.)

Note.—The area of the outside of the pipe is used in calculating the radiating surface.

2. Find the weight of an oak beam 6″x8″ in section and 13′ long. Of a steel bar 1″ in diameter and 13 feet long. Of sandstone, 18″x24″x9′.

10″ pipe nominal inside diameter.

4. Estimate the weight and cost of the piping system shown on the sketch to be furnished by the instructor. (For the "Home Study" department any system will answer. Piping layouts are frequently published in the technical magazines.)

New Building Stone.

The firm of Jencqual & Hayn, of Hamburg, Germany, have patented a process for manufacturing an artificial building stone from infusorial earth, which they call guhrolit. This stone is very light, is fireproof, withstands the influence of most chemicals and can be easily sawed, nailed, and bored.—Walter Schumann, Consul Mainz, Germany.

CURRENT TOPICS.

Civil Service Examinations.

The United States Civil Service Commission announces an examination on January 4, 1905, to secure men to fill vacancies in the positions of foreman of diamond drill boring party, foreman of wash boring party, and boring party helper; also assistant foreman, foreman and general foreman of laborers.

On January 18, 1905, there is to be an examination for clerk, bookkeeper, timekeeper, surgeon, physician, pharmacist, hospital interne, trained nurse, assistant civil engineer, instrument man, transit man, level man, rod man, chain man and helper.

All positions are on the Isthmus of Panama under the Isthmian Canal Commission, and the examinations are to be held at a large number of places.

For details address U. S. Civil Service Commission, Washington, D. C.

Various Forms of Tracing Paper.

An invention which has for its object the rendering more or less transparent of paper used for writing or drawing, either with ink, pencil or crayon, and also to give the paper such a surface that such writing or drawing may be completely removed by washing, without in any way injuring the paper, was patented some time ago. The object of making the paper transparent is that when used in schools the scholars can trace the copy, and thus become proficient in the formation of letter without the explanation usually necessary; and it may also be used in any place where tracings may be required, as by laying the paper over the object to be copied it can plainly be seen. Writing paper is used by preference, its preparation consisting in first saturating it with benzine, and then immediately coating the paper with a suitable rapidly-drying varnish before the benzine can evaporate. The application of varnish is by preference made by plunging the papers into a bath of it, but it may be applied with a brush or sponge. The varnish is prepared of the following ingredients: Boiled bleached linseed oil, twenty pounds; lead shavings, one pound; oxide of zinc, five pounds; Venetian turpentine, one-half pound; mix and boil five hours. After cooling, strain, and add five pounds white copal, six and a half pounds sandarac.

The following is a capital method of preparing tracing paper for architectural or engineering tracings: Take common tissue or cap paper, any size sheet, lay each sheet on a flat surface and sponge over (one side) with the following, taking care not to miss any part of the surface: Canadian balsam, two pints; spirits of turpentine, three pints; to which add a few drops of old nut oil; a sponge is the best instrument for applying the mixture, which should be used warm. As each sheet is prepared it should be hung up to dry over two cords stretched tightly and parallel, about eight inches apart, to prevent the lower edges of the paper from coming in contact. As soon as dry, the sheets should be carefully rolled on straight and smooth rollers covered with paper, about two inches in diameter. The sheets will be dry when no stickiness can be felt. A little practice will enable any one to make good tracing paper in this way at a moderate rate. The composition gives the substance to the tissue paper.

You may make paper sufficiently transparent for tracing by saturating it with spirits of turpentine or benzoline. As long as the paper continues to be moistened with either of these you can carry on your tracing; when the spirit has evaporated the paper will be opaque. Ink or water colors may be used on the surface without running.

A convenient method for rendering ordinary drawing paper transparent for the purpose of making tracings and of removing its transparency, so as to restore its former appearance when the drawing is completed, has been invented by M. Puschers. It consists in dissolving a given quantity of castor oil in one, two or three volumes of absolute alcohol, according to the thickness of the paper, and applying it by means of a sponge. The alcohol evaporates in a few minutes, and the tracing paper is dry and ready for immediate use. The drawing or tracing can be made either with lead pencil or India ink, and the oil removed from the paper by immersing it in absolute alcohol, thus restoring its original opacity. The alcohol employed in removing the first oil is, of course, preserved for diluting the oil used in preparing the next sheet.

Put one-quarter ounce gum mastic into a bottle holding six ounces best spirits of turpentine, shaking it up day by day; when thoroughly dissolved it is ready for use. It can be made thinner at any time by adding more turps. Then take some sheets of the best quality of tissue paper, open them, and apply the mixture with a broad brush. Hang up to dry.

Corbon tracing paper is prepared by rubbing into a tissue a mixture of six parts lard, one of beeswax, and sufficient fine lampblack to give it a good color. The mixture should be warm, and not applied in excess.

Sa urate ordinary writing paper with petroleum and wipe the surface dry.

Lay a sheet of fine white wove tissue paper on a clean board, brush it softly on both sides with a solution of beeswax in spirits of turpentine (say about one-half ounce in half pint), and hang up to dry for a few days out of the dust.—*National Builder*.

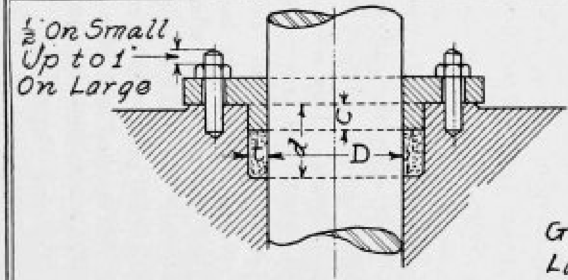
The Need of Shop Training.

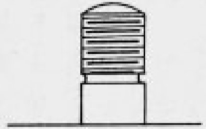
It has been pointed out many times, says the London Engineer, that practical engineering is not pure science. The designing and construction of a good bridge, or a good engine, represents only half the work that has to be done. No one of importance or influence works as an engineer, or makes bridges, or roofs, or engines, for the fun of the thing. These are made to be sold. That is the great fact that the professor and the technical schoolmaster ignore. They cannot teach anything about the price of materials or labor. They regard that aspect of engineering either with a languid interest or unqualified disgust. They hold that such matters do not come within their province, and it may be conceded that in a sense they are right. But the result is none the less unsatisfactory. Over and over again the same statement is made by the manufacturing engineers whenever education is discussed, that they cannot obtain men who know what work ought to cost. Under a proper system of technical education the young engineer would be taught not only how to make designs, but how to estimate the price at which they can be carried out—not necessarily with minute accuracy; yet the mere fact that the subject formed part of an examination paper would open his eyes to its importance. It is quite as necessary that the engineer should know what the eyed link in a suspension bridge chain will cost as to be certain what stress can be put on it with safety. It is not less important that he should clearly understand how much money must be expended to drive a hundred 30-foot piles, as it is that he should know how many blows of a monkey each will require to send it home, and what load it will then carry. The man who thoroughly understands the difference between good and bad riveting has mastered only the rudiments of his subject, unless he is also competent to say what any seam will cost under all possible conditions.

Editor; The Draftsman.

I noticed in a recent issue of The Draftsman an article with a title similar to the above. I have used the typewriter a great deal for a variety of work where blue print duplicates were needed and can say that the results are very satisfactory. May I be permitted to add a little to the article above referred to. When the typewriter ribbon is new, excellent copies may be made from the original, but when the ribbon becomes somewhat worn, it may be reinforced in the following manner: Place a piece of carbon paper in the machine with the original paper with the carbon side next to the paper on which the original is to be made. This will be exactly opposite to the way in which this paper is usually used and will give a reverse copy on the back of the original sheet. Those who use the typewriter for making originals from which blue prints are taken will find that this method will give much better copies.—Arthur B. Babbitt, Manual Training Department, Hartford Public High School, Hartford, Conn.

VARIOUS HYDRAULIC PACKINGS & JOINTS.

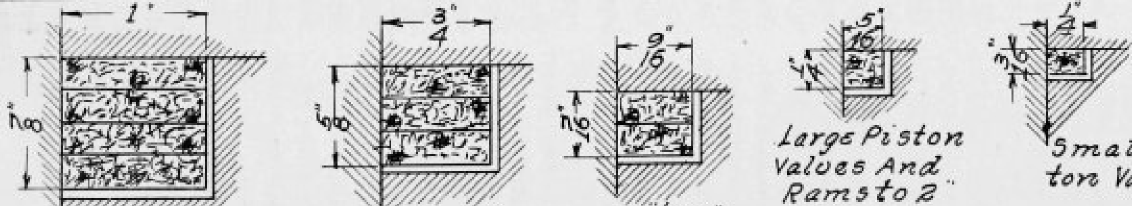




Groove Stud on Large Rams. Allow 5000# Stress In Studs At Root Resulting from Annular Space X Pressure.

D	1-1½	1½-3	3-5	5-8	8-12	12-20	20-24
t	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
c	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$
d	2	3	4	5	6	7	8

Glands are Screwed Home When Packed.



Rams Above 8" 4" to 8" 2" to 4"

Cylinder Packing Turned To Fit Cyl. Ram Packing Bored To Fit Ram. All Other parts Left Rough.

Leathers are specially selected Hide Of Uniform Thickness Of About $\frac{3}{16}$". Selected as Solid as Possible And After Being Prepared Is Soaked In Melted Parafine. Multiple Leathers Are Stitched Together. Has Proven Entirely Satisfactory On 4000# ☐" And Has been Occassionaly Used On 6000# Pressure.

The Beginnings of A B C.

How did men first come to invent their A B C? Whence did the familiar letters arise? In half a century—between the edition of the "Encyclopædia Britannica" of 1853 and the *new* (not the *old*) volumes of the *Times* edition—three sets of answers have been given. The third time is lucky! In 1853 the writer in the "Encyclopædia" on the alphabet kindly offered us a choice of three theories: 1. Adam invented letters. 2. Letters have existed from all eternity. 3. They came by divine revelation—to somebody unnamed. This lacks common sense!

Next, if you look up "alphabet" in the *old* volume of the *Times* edition (1875), you will find something more sensible, but almost wholly erroneous. The letters, we learn, came thus: First, savages design pictures representing a series of events, and draw them in skeleton outlines, like "Tommy Traddles," in "David Copperfield." To take a red Indian example, you scratch twenty-three erect strokes on a bit of birch bark; that means twenty-three braves. Then you draw a bottle-nosed face, with short hair stricking up all around it, head, cheeks and chin. That is the sun. Below it you put ten horizontal strokes; this means that the twenty-three warriors were for ten suns, or days, on the warpath. You next sketch three rude ground plans of forts; this means that three English forts were attacked. You put in ten isosceles triangles reversed, with their limbs produced from the apex. This means ten men lost to his Britanic Majesty's forces. On the bases of four of the ten triangles are dots. This means that four of the ten English soldiers have kept their heads on, and are living prisoners. You now draw a tortoise in one corner; this may be the signature of the writer, a man of the tortoise totem; or it may symbolize land, and mean "all right."

This process is pure "picture writing."

You can understand it without knowing the Choctaw language.

The next step is to draw real objects with a symbolical meaning; a picture of a pipe stands for peace, of a bird on the wing for "hurry up," of a fire for a family. A tract printed for the conversion of the Mikmak Indians needed 5,701 of these characters, and the results perhaps did not justify the outlay.

The next step toward the alphabet is to draw pictures which represent the sounds of words. To make "buoyant" (sounds *boyant*) you design a skeleton figure of a boy, and another of an elderly lady, his aunt. There was a Mexican king called Itzcoatl, from *itz* (a knife) and *coatl* (a serpent). His name was written with pictures of several knives on the back of a snake.

By these steps we reach ancient Egyptian hieroglyphs. The Egyptian word for an owl was *mulak*. First an owl was represented, cut on stone, an unmistakable owl. Next, the owl picture stood for the syllable, or sound, *mu*, the first syllable of *mulak*. Next, the owl picture means only M.

Then the Egyptians took not only to cutting inscriptions on stone, but also to writing on paper made of papyrus. The scribe scamped his owl and produced a skeleton picture rather like a goose with a broken neck, looking over its shoulder. A yet more rapid style of writing, in very thick ink, called the "hieratic" style, reduced this figure of a ramshackle goose to a dissipated character or a *b* of undecided character.

Now the theory of the origin of our alphabet, in the *old* volumes of the *Times'* "Encyclopædia Britannica" (1875) is that the Phœnicians, say, about 1,500 to 1,200 B. C., borrowed their letters (which are certainly the origin of our modern A, B, C, *as we now use them*) from these hieratic Egyptian scribbles, which again descend, as we saw, from Egyptian pictures of owls and other animals and things.

This theory, worked out by the Vicomte de Rouge, in 1859, was not published till 1873; because his manuscript had been lost; luckily a rough draft was discovered after his death. The theory is, we must remember, that men first made a picture, say, of an owl, then the picture came to represent the first syllable (*mu*) of *mulak* (an owl), then the picture stood for the first letter only (M) of *mulak*, then the picture, written in pen or brush and ink, degenerated into a scrawl, then the Phœnicians adopted the scrawl, and circulated it in commerce as part of an alphabet. Then the Greeks borrowed it and made it M. Finally the Romans borrowed it from the Greeks, and our ancestors from the Romans. And so on with the other letters.

B was an Egyptian crane, Z was a duck, L was a lion couchant, R was a human mouth, and so forth, and so forth.

This theory, which is stated here from Mr. Isaac Taylor's book, "The Alphabet" (1883), is de Rouge's theory, and the theory of the *old* first volume of the *Times'* "Encyclopædia Britannica." Prof. Max Muller and many other learned people accepted it, and it ran for about twenty years, more or less. But Lagarde, a great scholar, made objections. I need only mention *one*—the Phœnician letters, as a rule, were *not in the least like* the hieratic scribbles, not to mention that the hieratic scribblers were *not in the least like* the picture of the owls and cranes and ducks from which, according to the theory, they were derived. To the *ordinary* mind that one objection is very strong. For example, we are led to believe that A was, first, a picture of an eagle (hieroglyph), then became like a snake erecting its crest (hieratic), and then two strokes meeting in an angle, with a third stroke across them (like our A if you laid it down on its left side), and *that* was the Phœnician letter *aleph*, which means "an ox." Set on its legs again, it became the Greek *Alpha*, our A. The Phœnician letter, *aleph*, an ox, in fact, is rudely like an ox's head, with horns. The original hieroglyph, the eagle (a serpent in hieratic), is *diablement change en route* when it becomes an ox's head, horns and all. The hieratic form is infinitely more like an ox's tail! A human mouth (hieroglyph) is not like a serpent biting its own stomach (hieratic), nor is "an inundated garden" (hieroglyph) like a horned serpent (hieratic), while *that* is unlike a small written *w* (Phœnician), which, stuck up erect is the Greek character, our S. A bowl (hieroglyph) does not resemble a tomahawk (hieratic), nor is *that* like a three-pronged fork (Phœnician), our K.

For these eminently commonplace reasons, which at once occur to the human mind, de Rouge's theory looks "too thin." This it does even while we remember that the hieratic characters in Egypt were written with thick black ink on a kind of paper, while the Phœnician letters were chipped on stone, with a natural preference for straight lines, which would cause them to lose likeness to the curved hieratic. It was on stone that the Egyptians chipped their hieroglyphs, yet these pictures are full of curves. However, there is another argument against the theory that the Phœnician letters were borrowed from the Egyptian hieratic. Not only are they quite unlike hieratic characters, but characters very like the Phœnician letters, and still more like our own, were common in Egypt and Southern Europe from France to Egypt, long before there was any hieratic writing at all, or even any hieroglyphs. Nobody knows how many tens of thousands of years have passed since skin-clad men, armed with huge, sharpened, chipped flints, hunted the reindeer and the mammoth in France and England. These men, especially in France, were admirable artists; their sculptures, etched sketches and paintings of mammoths, reindeer, horses, kine, pike and trout are simply astonishing. They are clearly designed with the eye of the artist on the object. Now, on decorated bones and reindeer horns left by these people, far more ancient than the Egyptians, we find a few alphabetic characters, such as the Greek U and an old Greek character like an arrow with a barbed head, and the letter A, and other recognizable letters, such as E, I, on painted pebbles of this race. Why they made these designs, which look like real letters, is not known; perhaps they were owners' or artists' marks; they are not mere ornament.

Next, on Egyptian pottery perhaps of 6,000 B. C., Prof. Flinders Petrie has found all the letters of the Greek alphabet at large, thousands of years before the Phœnicians ever wrote a line. Many of these letters are more like our own than they are like the Phœnician or Greek, but the most common is what I have called the three-pronged fork, with the prongs very wide apart, the Greek *psi*. Taking them at random, we find our B, the Greek form of P, our E, F, O, I, H, V, the Greek L (V reversed), the Greek *phi*, A, the Greek G, the Greek Z, T, the Greek D X, in a line the Greek for A L T; M Y with a sign exactly like a ball going over the bails of four stumps; a wicket with the central stump bowled down (leaving the bails out!); N, the Roman thirteen (XIII), our I D, and so on, with many other characters *not* found in real alphabets.

This is not nearly all. In 1873 Dr. Schliemann found several of the signs engraved on clay "whorls" on the site of Troy, but of an age long before the Phœnicians were busy. Then Mr. Arthur Evans noticed many signs like writing on very ancient seals of the Greek islands, and he concluded that there was writing before the Phœnicians invented our alphabet. He discovered many more such seals in Crete, and, at last, dug up whole libraries of clay tablets, with writing in lines, "linear writing," all very much older than Phœnician trade. He also found most of the Greek letters engraved on bone fishes, perhaps counters in a game, one letter on each fish. We do not know what the very early Egyptian meant by the characters so like our own letters. We do not know what the Clydesdale people meant by several of the same characters on their slate amulets. I ought to say that the gentlemen who found them (Mr. W. A. Donnelly and Mr. John Bruce), never said anything about these characters, nor did those who called the things forgeries. I only happened in December, 1903, to notice the Egyptian resemblances. However, Mr. Evans' Cretan finds certainly were covered with real writing, long before the Phœnicians' "invention" of the alphabet. On a Cretan seal of perhaps 2,500 B. C. he found two characters. In Greek they would read (in our letters) U over P and the same U over P come on a slate amulet discovered in the Clyde! This must probably be a mere chance coincidence, but it is odd. In some of Mr. Evans' seals you see rude skeleton pictures turning into letters, but one bears the monogram K M and the other the monogram W P, if read as our own letters; also there is M D in a monogram. On one broken stone table Mr. Evans found that, out of four characters three tallied with old Greek forms, though a thousand years earlier than the oldest known Phœnician (or, rather, Semitic) inscriptions. Three also appear in Libya, on the southern side of the Mediterranean.

What is perhaps still less expected, the greater part of the alphabet turns up in regular inscriptions from stones above tombs, in Spain and Portugal, the X being the same as the red Indian figure that represents a man with his head off. These tombs are prehistoric, and earlier than Phœnician trade in Spain. Nobody doubts that these Spanish and Portuguese letterings on tombs—epitaphs, in short—are genuine. They are written between horizontal incised lines, as children are taught to write on ruled paper.

Next, similar characters, thirty-four in all, were found on various small tablets of stone, under a dolmen, or artificial chamber of gigantic unhewn slabs of rock, in Portugal, in 1895. The A lies on his left side, like the Phœnician *Aleph*. The Greek U, K, L, M, N, H, Ps, D, I, E, and other characters, can be recognized by a child. Now these dolmens were raised by people who have left no metal implements, only knives of hard stone and axes of the same, with minute fragments of the rudest pottery. It should follow that alphabetic characters (whatever their meaning may have been) were well known to people in Portugal thousands of years before the Phœnician sailed to the pillars of Hercules, and

"Sly traffickers, the dark Iberians
came."

But the alphabetic marks were found with a cartload of little stone female idols, stones marked with small, round cups, stones scratched with grotesque figures of beasts, stones rudely shaped like queer animals, and others with grotesque human faces.

Thus we can not say that these very ancient Portuguese letters are genuine, though the late Don da Veiga believed that letters were of this vast antiquity in Portugal, and he was the highest Portuguese authority. The objection that "early Portuguese did not write Greek" was made by somebody who did not know that signs resembling old Greek letters are "all over the place." They occur on the pots of an ancient people in Panama and in the tattoo marks of natives of New Guinea, as well as in Europe and Egypt.

The conclusion arrived at by Mr. Taylor, in 1883, that all alphabets descend from the Egyptian pictured hieroglyphs, through the Phœnicians, is therefore abandoned, or reckoned less probable, in the *new* volumes of the *Times'* "Encyclopædia Britannica," under the head "Writing." As Prof. Flinders Petrie says, "The so-called Phœnician letters were familiar long before the rise of Phœnician influence." The Phœnicians only selected and adapted, as numerals, about half of the older signs, the others vanished, except in Asia Minor, Spain and Portugal. There is not one early Greek alphabet, but many, "so diverse that each has to be learned separately." "Each tribe had its own signs for certain sounds, varying a good deal, yet each had to follow the same numerical system"; that is, had to use the same sign for numerals (1, 2, 3, 4, 5, etc.) as the Phœnicians used in commerce. "The history of the alphabet is as old as civilization." Today we write (at least in U, T, E, I, A) letters which the reindeer and mammoth hunters of France used for some purpose of their own, a countless number of thousands of years ago. Were these signs in origin degenerate skeleton pictures of things? I doubt it! The reason of my doubt is that Melanesians in New Guinea, and prehistoric Chiriquis in Panama, and prehistoric Egyptians before the Pharaohs arose, and dwellers in Spain and Portugal, and men in France when mammoths roamed there, were not very likely, if they began by drawing animals, to simplify the designs into the same alphabetic looking forms all round the globe.—*New York Independent.*

The Metric System In Coins

It may not be generally known that we have, in the nickel five-cent piece of our coinage, a key to the tables of the linear measures and weights of the metric system. The diameter of this coin is 2 centimeters, and its weight is 5 grammes. Five of them placed in a row will, of course, give the length of the decimetre; and two of them will weigh a dekagram. As the litre is a cubic decimetre, the key to the measure of length is also the key to the measures of capacity. Any person, therefore, who is fortunate enough to own a five-cent nickel may be said to carry in his pocket the entire metric system of weights and measures.—Self Education.

(The common V-nickel five-cent piece is 21 millimeters, or one more than 2 centimeters in diameter.)

Hot Air.

The following is part of an article seen in a local newspaper: "Laisy's airship is unique in construction. The gas bag is forty feet long, eighteen feet in diameter, and forty feet in circumference, and holds when inflated. 20, 000 cubic feet of gas. A central beam runs through the gas bag. This bag is intented to turn around and around and with the aid of queer looking contrivances on the sides to rush through space. The inventor says the principle is much the same as that of an auger in motion."

To the average reader the dimensions given would appear all right, but on second thought many of these readers would notice something wrong with the figures. Do you?

First, the bag could not be 40 feet in circumference and 18 feet in diameter for 18′ x 3.1416=56. 54 feet circumference and if 40 ft. in circumference it would only be 12′ 9″ in diam.

Second, if it was 18 ft. in diameter, 40 ft. long and spherical on the ends it would hold only 8650.23 cu. feet of gas and if only 40 ft. in circnmferance it would hold only 4565 cu. ft. of gas, hence we say, "Too much hot air," and this often occurs in newspaper reports of mechanical appliances.

Book Notices.

The Up-to-Date Hardwood Finishers, by Fred T. Hodgson. 200 pages 5x8. Fully Illustrated. Cloth bound. Price $1.00. Frederick J. Drake & Co. Publishers. Chicago, Ill.

The book is arranged in two parts, the first devoted Wood,s tools and the second to coatings, fillers and finishing.

The description of woods for hard wood finishing is very complete and is conclude l with explanations of the manner of putting them together.

The knowledge of the kind and care of tools for this work is a matter well worth the study of the woodworker and being well illustrate l will be much value to him.

Part two is confined to the manners of finishing woods with fillers and gives many receipts and instructions that are very practical.

Different colors of staining, ebonizing, polishing and the particular manner of treating various woods is here discussed together with the many tools and brushes.

Wire and Wireless Telegraphy by E. B. Moore. This is one of the latest and most popular books published. In this little volume the author endeavors to give a brief bnt intelligible and connected description of the science and history of the electric telegraph, practical applications and a brief sketch of the developments.

Much care has been taken in preparing the chapters in the latter part of the book which give a very good idea to the reader of the present systems and stations of wireless telegraph.

It is written in good, plain language so that the amateur may readily understand and comprehend it, also the professional may find it interesting and to contain many good points well worth notice.

Mail 50 cts. to E. B. Moore, Springfield, Vt., and receive by return mail one (1) copy of this latest book, Wire and Wireless Telegraphy, which has just been published.

Remittance may be made by money order if desirable. Postage stamps accepted. Mentiou The Draftsman.